✓605 v.15

BRENT WILEY, EDITOR
JAMES D. KELLY, ADVERTISING MGR.

BOARD OF DIRECTORS

PRESIDENT
L. F. COFFIN,
Superintendent
Mechanical Department
Bethlehem Steel Company
Sparrows Point, Md.

1ST VICE PRESIDENT, C. C. WALES, Assistant General Manager, Algoma Steel Corporation, Saulte Ste. Marie, Ontario, Canada.

2ND VICE PRESIDENT, W. A. PERRY, Superintendent Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Indiana.

DIRECTOR-AT-LARGE, M. J. CONWAY, Fuel Engineer, Lukens Steel Company, Coatesville, Penna.

HONORARY DIRECTORS, JAS. FARRINGTON, Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio.

E. FRIEDLANDER, Pittsburgh, Penna.

A. C. CUMMINS, Assistant Manager of Operations, Pgh. District, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

PAST PRESIDENTS, H. G. R. BENNETT, Assistant General Superintendent, Carnegie-Illinois Steel Corporation, Duquesne, Penna.

G. R. CARROLL, Elec. Superintendent, Jones and Laughlin Steel Corporation, Aliquippa, Pa.

TREASURER, F. E. FLYNN, General Manager, Warren District, Republic Steel Corporation, Warren, Ohio.

SECRETARY, J. L. MILLER, Assistant Chief Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio.

DIRECTOR, C. C. PECU, Lubrication Engineer, Bethlehem Steel Company, Lackawanna, N. Y.

DIRECTOR, C. L. McGRANAHAN, Assistant General Superintendent, Jones & Laughlin Steel Corporation., Pittsburgh, Penna.

DIRECTOR, J. A. CLAUSS, Chief Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

DIRECTOR, F. E. LEAHY, Fuel Engineer, Youngstown Sheet and Tube Company, Youngstown, Ohio.

DIRECTOR, E. C. MARSHALL, Chief Electrical Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

DIRECTOR, I. F. HEADLEE, Assistant to Chief Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana.

DIRECTOR, J. E. HARRELL, Chief Electrician, Tennessee Coal, Iron and Railroad Co., Fairfield, Alabama.

DIRECTOR, E. F. BLANK, Director Industrial Relations, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

DIRECTOR, A. W. STEED, Maintenance Superintendent, American Rolling Mill Company, Middletown, Ohio.

MANAGING DIRECTOR
BRENT WILEY
Empire Building, Pittsburgh, Penna.

IRON AND STEEL ENGINEER

VOL. XV JANUARY • 1938 NO. I

CONTENTS

Studies of Regenerative and Recuperative Furnaces—By W. A. Morton, President, Amsler-Morton Company, Pittsburgh, Penna. 25

DISCUSSION—Studies of Regenerative and Recuperative Furnaces—Presented by M. J. Conway, M. J. Bradley, E. W. Wagenseil, C. H. Thompson, L. F. Coffin, W. A. Morton, A. J. Fisher and Linn Bradley 35

Jones & Laughlin's New 96" Continuous Hot and Cold Strip Mill ..... JL 1

Developments in Welding During 1937—By G. A. Hughes, Chief Electrical Engineer, Truscon Steel Company, Youngstown, Ohio 41

Developments in the Iron and Steel Industry During 1937—By W. H. Burr, Chairman, Developments Committee, A. I. & S. E. and Electrical Superintendent, Lukens Steel Company, Coatesville, Penna. 46

Electric Motors Over 300 Horse Power Applied to Main Roll Drives in the Iron and Steel and Allied Industries During the Year 1937 56

Statistics and Analysis of Electric Motors Over 300 Horsepower Sold for Main Roll Drive Service in the Iron and Steel Industry in 1937 58

Electrically Operated Crane Statistics—1937 65

Recently Completed Modernization at Wisconsin Steel Works 66

A Look at the Three-High Sheet Mill 70

Latest Design and Equipment for the Industry 75

Items of Interest 79

Index to Advertisers 10

The President's Message 12

Newly Elected Officers and Directors—Association of Iron and Steel Engineers 1938 14

National Committees for 1938—Association of Iron and Steel Engineers 16

Join the Steel Industry's Only Engineering Society—The Association of Iron and Steel Engineers 19

Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879. Single Copy $1.50
Subscription price in U. S. & Canada ..... $5.00 per year
Subscription price in foreign countries ..... $7.50 per year

PLASTIC BINDING U. S. PATENT NO. 1970291 LICENSE NO. 10

4 ADVERTISING PAGES REMOVED

Control panels for D-C. power to reel motors

Tick! Tick! Between every two clock beats, 118 feet of white-hot pencil-size rod pours from this continuous mill at Joliet, Illinois. In two streams it comes, at 40 miles an hour, coiled on two reels, with ten more waiting for their loads. Electrically driven reels are timed to mill speed, with split-second accuracy. A fraction of a second too fast or too slow . . . and the fireworks start!

★ ★ ★

For designing, building, and installing motors and controls to keep step with this modern mill, the plant owners came to Westinghouse. They know that Westinghouse is more than a manufacturer of things electrical. They count Westinghouse as a partner, with engineers trained in steel and iron, alert to new developments, keeping pace electrically with the mechanical progress of the industry.

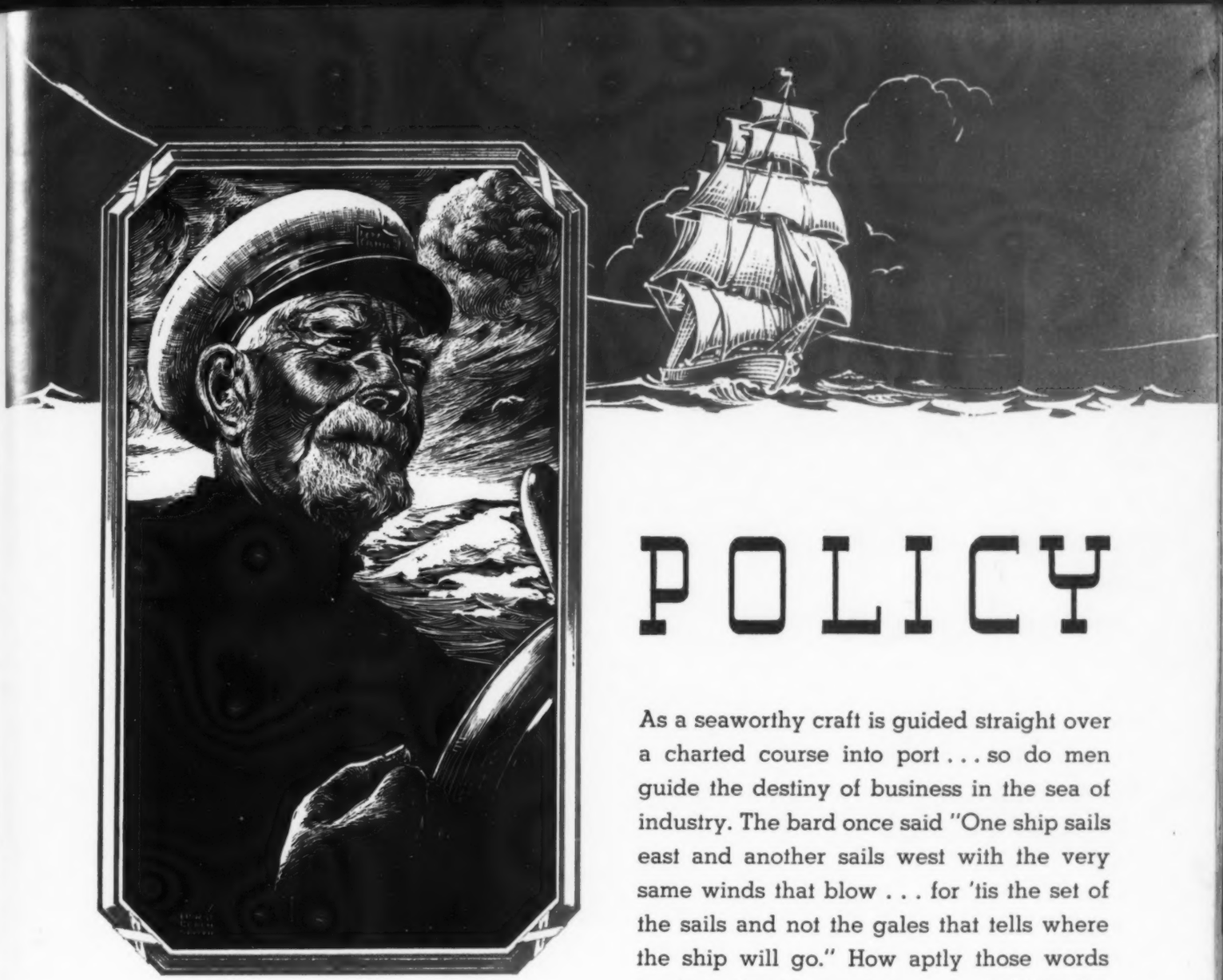
Whether your needs be complete electrification, or merely a device costing a few dollars, Westinghouse will serve you well. See your local office, or write Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

W WESTINGHOUSE ELECTRIC

Westinghouse

J 91756

DETROIT MICH



POLICY

As a seaworthy craft is guided straight over a charted course into port . . . so do men guide the destiny of business in the sea of industry. The bard once said "One ship sails east and another sails west with the very same winds that blow . . . for 'tis the set of the sails and not the gales that tells where the ship will go." How aptly those words apply to the unswerving course held by the Bull Dog Electric Products Company. The policy of the Bull Dog Electric Products Company is the charted course over which this business is guided . . . the policy of holding true to high ideals . . . the policy of permitting only proven and scientifically perfect products to be produced under the Bull Dog name . . . the policy of ever striving to improve . . . a policy of keeping faith with you.

Vacu-Break
Safety Switches
Panel Boards
Switch Boards
Duct Systems

BULL DOG ELECTRIC PRODUCTS CO.

DETROIT — MICHIGAN

Bull Dog Electric Products of Canada, Ltd., Toronto, Ont.

BULL DOG

PRODUCTS • POLICY • PERSONNEL

L. F. Coffin

PRESIDENT

Association of

IRON & STEEL ENGINEERS

1938

THE *President's* MESSAGE

Our organization has passed through its first year under its new name of "The Association of Iron and Steel Engineers". While this change in name and the dropping of the word "Electrical" indicates a broadened scope of activity, this widened field has been reached gradually; and even before the actual change in name. That our association holds a unique position among engineering organizations in that it embodies Electrical, Mechanical, Combustion, Welding, Lubricating, Safety, Metallurgical and Operating men in its membership is not strange. How could it be otherwise and give us the strength required?

The steel industry and expansion must go together. Picture if you can, a major construction program at any plant, properly and successfully executed without the utmost of contact, weekly, daily and hourly between all of the groups above mentioned. The steel industry is not one, but many industries forged together into a unit because we are making from a basic raw material many widely diversified finished products.

Let us take one type of construction project that has engrossed the attention of many plants—that of building continuous hot and cold strip mills—and diagnose a few of the factors involved. The operating executive must determine the type of product the market needs or will absorb. The operator must specify reductions and speeds and finish desired; the metallurgical engineer approves these reductions and relates them to finishing temperatures; the mechanical engineer agrees that these requirements can be met by existing types of mills or designs new mills to such needs; the electrical engineer figures power and delicate split second control; the combustion engineer provides heating to suit and temperature measuring equipment; the welding engineer fabricates newly designed and cheaper and better machinery to enable the economics of the situation to be sound; the lubrication engineer specifies oil and grease systems and seals to protect bearing surfaces and keep them free from scale and water contamination; and in all these the safety engineer must have his finger. Nor is the picture complete without the sales representatives who, speaking for the manufacturers of steel mill equipment, give counsel and advice and leadership that is far reaching. Without one of these, what might the result become? With all these, capable and cooperating, the result must be success.

This then is the challenge to our Association, that we increasingly continue to weld together *all* of these operating and engineering interests and enthusiasms into an even stronger and more unified whole. This we must do by still further strengthening the tools already at our hand and by using them to their utmost usefulness. Better attendance at local section meetings, more prepared as well as extemporaneous discussion at meetings, increased contributions from active members in the form of papers and articles for "Iron and Steel Engineer" are some of the means to this end.

To our membership and to those who should be of our membership, there is little need of pointing out the material advantages at your very door, if you but make full use of the privileges of your associating with other engineers whose interests are linked with yours. To individual members the lack of full use of such membership may mean stagnation, loss of interest, failure; the full use of it, enthusiasm, a widening vision, the power to grasp the opportunity when it arises. To those many companies and operating executives who encourage engineers and insist on their full participation in the activities of the Association of Iron and Steel Engineers and other engineering societies, the reward is the reasonable assurance of an alert, progressive and cooperative staff. To our Association, failure to co-ordinate and to lead and to push forward into wider fields will mean decay.

Your Officers and Directors assume their responsibilities fully recognizing the high standards that have been set for them and pledging their best efforts in advancing the integrity and prestige of our Association.

C. CLARKE WALES
First Vice President

WILLIAM A. PERRY
Second Vice President

FRANK EDWARD FLYNN
Treasurer

MARTIN J. CONWAY
Director at Large

NEWLY ELECTED OFFICERS AND DIRECTORS

C. Clarke Wales, assistant general manager, Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ontario, Canada, after being graduated from the University of Toronto with a degree of B.A., S.C. in mechanical engineering, entered the employ of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pennsylvania. In 1925 he joined the Otis Steel Company later becoming assistant metallurgist and then superintendent of the open hearth, 40″ blooming mill and bar mills. For the next seven years served as chief engineer of this company during which period he directed and planned the construction of the 72″ hot and cold strip mills. In 1937, he was appointed as assistant general manager of the Algoma Steel Corporation, Ltd. of Sault Ste. Marie, Ontario, Canada.

William A. Perry started with the Inland Steel Company twenty-seven years ago, and successively held the positions of mill motor foreman, assistant superintendent of power stations, and assistant electrical superintendent. He was advanced to his present position as superintendent of the electrical and power departments with the company in January 1931.

Martin J. Conway was educated in mechanical and chemical engineering at Hanley and Oxford Universities, England. From 1920 to 1923 he was fuel engineer for Pittsburgh Crucible Steel Company, Midland, Pennsylvania, and held a similar position at the Steubenville, Ohio, plant of the Wheeling Steel Corporation from 1923 to 1926. For the past twelve years he has been associated with the Lukens Steel Company, Coatesville, Pennsylvania, as fuel engineer.

Alden C. Cummins, assistant manager of operations, Pittsburgh District, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania, was first employed by the Duquesne Steel Works of the Carnegie Steel Company as an electrical draftsman in 1911, continuing with the company in various positions of responsibility until 1932, when he was appointed assistant general superintendent of the Duquesne Works. In 1933 he was promoted to general superintendent, which position he held until his advancement, in August 1936.

Frank Edward Flynn started in the steel business with the Superior Steel Company at Carnegie, progressing from the position of water boy to that of boss roller. In 1916, he started in charge of rolling at the Phillips Sheet and Tin Plate Company, which later became the Weirton Steel Company, and during his 11 years service there he became assistant manager and then manager. He came to the Trumbull Steel Company in 1928, as assistant vice president in charge of operations. This company later became a unit of Republic Steel Corporation, and he was made assistant district manager. When the general offices of Republic Steel Corporation were moved to Cleveland, he became general superintendent in charge of all operations at the Warren Division, which is composed of the Warren, Niles, Trumbull Cliffs and Newton Falls Works. In April 1937 he was appointed as general manager of the Warren-Niles district.

J. Ledlie Miller has been employed in the steel industry since 1909, serving as messenger, draftsman, and in the experimental engineering department of Carnegie Steel until he joined the Army, where served over seas as lieutenant in the heavy field artillery. Serving as fuel engineer at the Bellaire works of Carnegie from March 1919 until the steel strike that fall, he returned to the Carnegie Institute of Technology where he received his degree in mechanical engineering the following year.

Mr. Miller returned to Bellaire as fuel engineer and when this plant was closed, went to the Follansbee Brothers plant in Toronto, where he was annealing department foreman and assistant metallurgist until January 1, 1925. He served as fuel engineer of the Wheeling Steel Corporation in the Wheeling district from 1925 until he went to Youngstown for Carnegie in 1928. He acted as assistant chief engineer of Carnegie-Illinois Steel Corporation in the Youngstown district from 1928 to 1936. In 1937 he was appointed assistant combustion engineer of Republic Steel Corporation, with headquarters in Cleveland.

Clinton Curler Pecu, has been with the Bethlehem Steel Company for thirty-five years, and has held his present position as lubrication engineer for twenty-eight years. Prior to his connection with this company he served for fourteen years as foreman of the spring department, Haviland Shade Roller Company, Vergennes, Vermont. He is now located at the Lackawanna plant of the Bethlehem Steel Company.

C. L. McGranahan's first work in the steel industry was in 1916 with American Sheet and Tin Plate Company. He worked in various positions with the company at their different plants until

JULIUS A. CLAUSS
Director

F. E. LEAHY
Director

J. F. HEADLEE
Director

J. LEDLIE MILLER
Secretary

ALDEN C. CUMMINS
Honorary Director

CLINTON CURLER PECU
Director

C. L. McGRANAHAN
Director

1931, allowing for one year World War Service. In 1931 he joined the Inland Steel Company as superintendent of the company's Indiana Harbor hot strip mill, resigning in February 1936, to take his present position as assistant general superintendent with the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. McGranahan was graduated from Pennsylvania State College in 1916 with a bachelor of science degree in civil engineering.

Julius A. Clauss started his steel mill career with the Lackawanna Steel Company, which company he was with for seven years. He then went with Corrigan-McKinney Steel Company for two and one-half years as chief designer and checker. Following this he was the chief draftsman for the William Tod Company at Youngstown, Ohio. Leaving this company he went with the Republic Iron and Steel Company as assistant chief draftsman for twelve years. The next three and one-half years he served as chief engineer for the Trumbull Steel Company, and from March 1929 he has been with the Great Lakes Steel Corporation, at Ecorse, Michigan, as chief engineer.

F. E. Leahy has been fuel engineer for the Youngstown Sheet and Tube Company for the past ten years. Prior to joining his present company, Mr. Leahy was with Carnegie Steel Company as steam and fuel engineer; and steam engineer and superintendent of power with National Tube Company. Mr. Leahy received his degree in mechanical engineering from Stevens Institute of Technology.

Edward C. Marshall, after attending the duPont Manual Training School in Louisville, Kentucky, specialized in electrical engineering, being employed at the General Electric Company, Schenectady, New York, from 1907 to 1913. He was transferred in 1913 to the company's Pittsburgh office as switchboard engineering specialist. In 1917, he left the General Electric Company, becoming general manager and chief engineer of the Keystone Electric Supply and Construction Company of Washington, Pennsylvania, where he remained until 1921, when he became assistant electrical engineer of the Hudson Coal Company, Scranton, Pennsylvania.

He became associated with the Youngstown Sheet and Tube Company, Youngstown, Ohio, in 1924, and from 1926 until 1935 was electrical engineer of their Chicago District, with offices at Indiana Harbor, Indiana. Two years ago he was appointed chief electrical engineer of the company with offices in Youngstown, Ohio, where he is now located.

J. F. Headlee worked as a commercial operator of ship and shore stations in the wireless telegraph field during the summer months of the period while attending Valparaiso University. He has been with the United States Steel Corporation subsidiaries for several years in various capacities, such as wireman, electrical foreman, electrical test engineer, and electrical engineer.

J. E. Harrell first began electrical work with the Birmingham Railway, Light and Power Company in 1903. In June 1907 he was employed by the Tennessee Coal, Iron and Railroad Company for construction work. He returned in 1908 to the Birmingham power company, and in August 1910 he was re-employed by the Tennessee Coal, Iron and Railroad Company as chief electrician of Bessemer division. In 1918 he was transferred to the new works at Fairfield as assistant chief electrician, and in 1923 was promoted to chief electrician holding that position until the present time .

E. F. Blank was born January 31, 1890, in Sault Ste. Marie, Michigan, and in 1911 was graduated from Biltmore Forest School with a bachelor of forestry degree. Mr. Blank was engaged in logging and civil engineering work in Canada, Maine, and Michigan from 1911 to 1915. In 1915 he joined the Ford Motor Company in the safety engineering department. From 1918 to 1925 he was with the industrial relations section of the General Motors Corporation. He was appointed in 1925 as director of safety and welfare for the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania, and later, in 1935, he became director of personnel relations for the Jones and Laughlin Steel Corporation.

A. W. Steed was graduated from the University of Missouri with a bachelor of science degree in mechanical engineering in 1910. Mr. Steed started in the same year, 1910, with the Westinghouse Machine Company. In 1915 he joined the American Rolling Mill Company at Middletown, Ohio, where he was employed in the power department. He was made power superintendent of this plant in 1923, and in 1929 he became superintendent of maintenance, holding this position until the present time.

EDWARD C. MARSHALL
Director

J. E. HARRELL
Director

E. F. BLANK
Director

A. W. STEED
Director

National Committees for 1938

ASSOCIATION OF IRON AND STEEL ENGINEERS

General Chairman—L. F. COFFIN—*President*

ADVISORY COMMITTEE

(Past Presidents A. I. & S. E.)

1907–1908	JAS. FARRINGTON, Elec. Supt., Wheeling Steel Corporation, Steubenville, O.
1909	JOHN C. REED, Electrical Engineer, Bethlehem Steel Co., Steelton, Pa.
1910	F. P. TOWNSEND (Retired) 192 Gregory Avenue, West Orange, N. J.
1911	L. R. PALMER, Conservation Engineer, Safety Dept., Equitable Life Assur. Soc., 393 Seventh Avenue, New York, N. Y.
1914	E. FRIEDLANDER, Kaufmann's, Pittsburgh, Penna.
1915	O. R. JONES (Retired) 914 Belmont Street, Youngstown, Ohio.
1917	F. D. EGAN, Elect. Supt., Bethlehem Steel Company, Lackawanna, N. Y.
1919	D. M. PETTY, Div. Supt., Bethlehem Steel Company, Lackawanna, N. Y.
1921	E. S. JEFFERIES, 3 Haviland St., Worcester, Mass.
1922	*Chairman*, W. S. HALL, Chief Engr., Chicago District, Carnegie Illinois Steel Corp., Chicago, Illinois.
1923	R. B. GERHARDT, Bethlehem Steel Company, Maint. and Power Supt., Steelton, Penna.
1924	R. S. SHOEMAKER, Representing Works Management, American Rolling Mill Co., Middletown, Ohio.
1925	A. C. CUMMINS, Asst. Mgr. Operations, Carnegie-Illinois Steel Corp., Pittsburgh, Penna.
1926	G. H. SCHAEFFER, Elec. Engr., Carpenter Steel Company, Reading, Pa.
1927	S. S. WALES (Retired) Box B, Westside Station, Youngstown, Ohio.
1928	A. J. STANDING, Elec. Supt., Saucon Div., Bethlehem Steel Company, Bethlehem, Penna.
1930	F. W. CRAMER, Elec. Engr., Carnegie-Illinois Steel Corporation, Pittsburgh, Penna.
1931	F. O. SCHNURE, Elec. Supt., Bethlehem Steel Company, Sparrows Pt., Md.
1932	J. J. BOOTH, Asst. Ch. Maint. Engr., Carnegie-Illinois Steel Corp., Duquesne, Penna.
1933	J. D. DONOVAN, Elec. Supt., Republic Steel Corp., Massillon, Ohio.
1935	W. H. BURR, Elec. Supt., Lukens Steel Company, Coatesville, Penna.
1936	GEO. R. CARROLL, Elec. Supt., Jones and Laughlin Steel Corp., Aliquippa, Pa.
1937	H. G. R. BENNETT, Asst. Gen. Supt., Carnegie-Illinois Steel Corp., Duquesne, Penna.

MEMBERSHIP COMMITTEE

Chairman: GEO. R. CARROLL, Electrical Superintendent, Jones & Laughlin Steel Corporation, Aliquippa, Pa.

T. E. HUGHES, Chief Maintenance Engineer, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

T. J. ESS, Combustion Engineer, Republic Steel Corporation, Massillon, Ohio.

W. W. SPANAGEL, Sales Department, Reliance Electric & Engineering Company, Cleveland, Ohio.

H. W. NEBLETT, Engineer, Inland Steel Company, Indiana Harbor, Indiana.

ARTHUR J. WHITCOMB, Electrical Engineer, Freyn Engineering Company, Chicago, Illinois.

R. R. THOMAS, Assistant Chief Engineer, Tennessee Coal Iron & Railroad Company, Ensley, Alabama.

BIRGER THELE, Electrical Department, Tennessee Coal Iron & Railroad Company, Fairfield, Alabama.

GEO. O. VANARTSDALEN, Chief Electrician, Henry Disston & Sons Company, Tacony, Philadelphia, Pa.

LINN O. MORROW, Schaff Building, Philadelphia, Pa.

STANDARDIZATION COMMITTEE

Chairman: F. D. EGAN, Electrical Superintendent, Bethlehem Steel Company, Lackawanna, New York.

Following committees to be appointed when and as required:

Mechanical Section
Electrical Section
Combustion Section
Lubrication Section
Welding Section
Metallurgical Section
General Section

DEVELOPMENT DIVISION COMMITTEE

Chairman: W. H. BURR, Electrical Superintendent, Lukens Steel Company, Coatesville, Pa.

W. A. PERRY, Electrical and Power Superintendent, Inland Steel Company, Indiana Harbor, Indiana.

H. G. R. BENNETT, Assistant General Superintendent, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

T. J. ESS, Combustion Engineer, Republic Steel Corporation, Massillon, Ohio.

G. A. HUGHES, Chief Electrical Engineer, Truscon Steel Company, Youngstown, Ohio.

F. L. GRAY, Test and Lubricating Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana.

JOHN L. YOUNG, Manager Machinery Sales, United Engineering & Foundry Company, Pittsburgh, Pa.

MYLES MORGAN, Assistant Chief Engineer, Morgan Construction Company, Worcester, Massachusetts.

R. W. DAVIS, Assistant Manager Electrical Department, Allis Chalmers Mfg. Company, Milwaukee, Wisconsin.

L. A. UMANSKY, Engineer, General Electric Company, Schenectady, New York.

W. H. WILLIAMS, Vice President, Clark Controller Company, Cleveland, Ohio.

G. E. STOLTZ, Engineer, Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.

R. G. WIDDOWS, Sales Manager, Electric Controller & Mfg. Company, Cleveland, Ohio.

R. J. LEWIS, Central District Sales Manager, Crocker Wheeler Electric & Mfg. Company, Pittsburgh, Pa.

F. J. BURD, Sales Department, Cutler-Hammer, Inc., Chicago, Illinois.

A. M. MACCUTCHEON, Engineer, Vice President, Reliance Electric & Engineering Company, Cleveland, Ohio.

A. T. DAVIS, Sales Manager, Morgan Engineering Company, Alliance, Ohio.

R. J. HARRY, General Manager, Alliance Machine Company, Alliance, Ohio.

C. H. SAITER, District Manager, Cleveland Crane & Engineering Company, Pittsburgh, Pa.

M. J. BRADLEY, Development Engineer, Leeds & Northrup Company, Philadelphia, Pa.

R. J. WEAN, President, Wean Engineering Company, Warren, Ohio.

R. E. MURPHY, Sales Manager, I-T-E Circuit Breaker Company, Philadelphia, Pa.

R. H. DEMOTT, Sales Manager, SKF Industries, Inc., Philadelphia, Pa.

S. M. WECKSTEIN, Assistant Chief Engineer, Timken Roller Bearing Company, Canton, Ohio.

R. G. MCDERMOTT, Vice President, Surface Combustion Corporation, Toledo, Ohio.

ELECTRICAL AND POWER ENGINEERING DIVISION COMMITTEE

Chairman: JOHN W. BATES, Electrical Engineer, Construction Engineering Division, Carnegie-Illinois Steel Corporation, Carnegie Building, Pittsburgh, Pa.

W. A. PERRY, Electrical and Power Superintendent, Inland Steel Company, Indiana Harbor, Indiana.

L. M. RIPPLE, Electrical Superintendent, Great Lakes Steel Corporation, Ecorse, Michigan.

G. N. HARMON, Electrical Superintendent, Republic Steel Corporation, Warren, Ohio.

H. R. MIDDLEBROOK, Power Superintendent, Carnegie-Illinois Steel Corporation, Gary, Indiana.

W. B. SKINKLE, Engineer Power Construction, Carnegie-Illinois Steel Corporation, Carnegie Building, Pittsburgh, Pa.

G. W. GREEN, Power Engineer, Bethlehem Steel Company, Lackawanna, New York.

GEO. A. KAUFMAN, Electrical Engineer, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

MECHANICAL ENGINEERING DIVISION COMMITTEE

Chairman: J. A. CLAUSS, Chief Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

W. S. HALL, Chief Engineer Chicago District, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

R. H. MCLAURIN, General Superintendent, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

C. L. MCGRANAHAN, Assistant General Superintendent, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

J. L. MAUTHE, General Superintendent, Youngstown Sheet & Tube Company, Youngstown, Ohio.

E. N. MILLAN, Chief Engineer, American Rolling Mill Company, Middletown, Ohio.

N. C. BYE, Chief Engineer, Henry Disston & Sons Company, Tacony, Philadelphia, Pa.

C. J. DUBY, Chief Engineer, Republic Steel Corporation, Youngstown, District.

J. A. MORTON, Steam and Fuel Engineer, American Steel & Wire Company, Cleveland, Ohio.

S. N. JENKS, Assistant General Superintendent, Carnegie-Illinois Steel Corporation, Gary, Indiana.

METALLURGICAL ENGINEERING DIVISION COMMITTEE

Chairman: C. L. MCGRANAHAN, Assistant General Superintendent, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

J. S. PASTORIUS, General Superintendent, Great Lakes Steel Corporation, Ecorse, Michigan.

T. J. ESS, Combustion Engineer, Republic Steel Corporation, Massillon, Ohio.

C. H. MANION, Chief Engineer, Follansbee Brothers, Follansbee, West Virginia.

R. S. SHOEMAKER, Representing Works Management, American Rolling Mill Company, Middletown, Ohio.

H. G. R. BENNETT, Assistant General Superintendent, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

C. D. KING, Metallurgist, United States Steel Corporation, New York, New York.

J. H. NEAD, Chief Metallurgist, Inland Steel Company, Indiana Harbor, Indiana.

J. H. VOHR, General Superintendent, Granite City Steel Company, Granite City, Illinois.

COMBUSTION ENGINEERING DIVISION COMMITTEE

Chairman: M. J. CONWAY, Fuel Engineer, Lukens Steel Company, Coatesville, Pa.

H. V. FLAGG, Assistant Combustion Engineer, American Rolling Mill Company, Middletown, Ohio.

J. L. MILLER, Assistant Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio.

C. H. VERWOHLT, Plant Engineer, Whitaker Works, Wheeling Steel Corporation, Wheeling, West Virginia.

F. E. LEAHY, Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

C. H. WILLIAMS, Assistant Chief Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

H. C. SIEBERT, Combustion Engineer, Bethlehem Steel Company, Bethlehem, Pa.

LUBRICATION ENGINEERING DIVISION COMMITTEE

Chairman: C. C. PECU, Lubrication Engineer, Bethlehem Steel Company, Lackawanna, New York.

F. L. GRAY, Lubrication Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana.

F. J. THOMAS, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio.

H. R. GILCHRIST, Lubrication Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

T. R. MOXLEY, General Master Mechanic, Wheeling Steel Corporation, Wheeling, West Virginia.

J. H. KREHL, Mechanical Superintendent, Youngstown Sheet & Tube Company, Youngstown, Ohio.

WELDING ENGINEERING DIVISION COMMITTEE

Chairman: G. A. HUGHES, Chief Electrical Engineer, Truscon Steel Company, Youngstown, Ohio.

T. E. HUGHES, Chief Maintenance Engineer, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

G. N. HARMON, Electrical Superintendent, Republic Steel Corporation, Warren, Ohio.

H. W. NEBLETT, Engineer, Inland Steel Company, Indiana Harbor, Indiana.

C. J. SMITH, Maintenance Superintendent, Carnegie-Illinois Steel Corporation, Gary, Indiana.

A. W. STEED, Superintendent Maintenance, American Rolling Mill Company, Middletown, Ohio.

D. M. PETTY, Division Superintendent, Bethlehem Steel Company, Bethlehem, Pa.

E. C. MARSHALL, Electrical Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

WRAY DUDLEY, Electrical Superintendent, National Tube Company, McKeesport, Pa.

INDUSTRIAL RELATIONS DIVISION COMMITTEE

Chairman: G. R. ADAIR, Assistant Director Public and Industrial Relations, American Rolling Mill Company, Middletown, Ohio.

EARL F. BLANK, Director Industrial Relations, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

R. L. LEFFLER, Manager Industrial Relations, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.

J. A. VOSS, Director Industrial Relations, Republic Steel Corporation, Cleveland, Ohio.

J. H. MCELHINNEY, Assistant to Vice President, Wheeling Steel Corporation, Wheeling, West Virginia.

D. M. PETTY, Division Superintendent, Bethlehem Steel Company, Bethlehem, Pa.

PAPERS COMMITTEE

Chairman: L. F. COFFIN, President.

J. A. CLAUSS, *Chairman*, Mechanical Engineering Division.

G. A. HUGHES, *Chairman*, Welding Engineering Division.

C. L. MCGRANAHAN, *Chairman*, Metallurgical Engineering Division.

M. J. CONWAY, *Chairman*, Combustion Engineering Division.

G. R. ADAIR, *Chairman*, Industrial Relations Division.

C. C. PECU, *Chairman*, Lubrication Engineering Division.

J. W. BATES, *Chairman*, Electrical and Power Engineering Division.

EDITING COMMITTEE

Chairman: R. S. SHOEMAKER, Representing Works Management, American Rolling Mill Company, Middletown, Ohio.

F. O. SCHNURE, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Maryland.

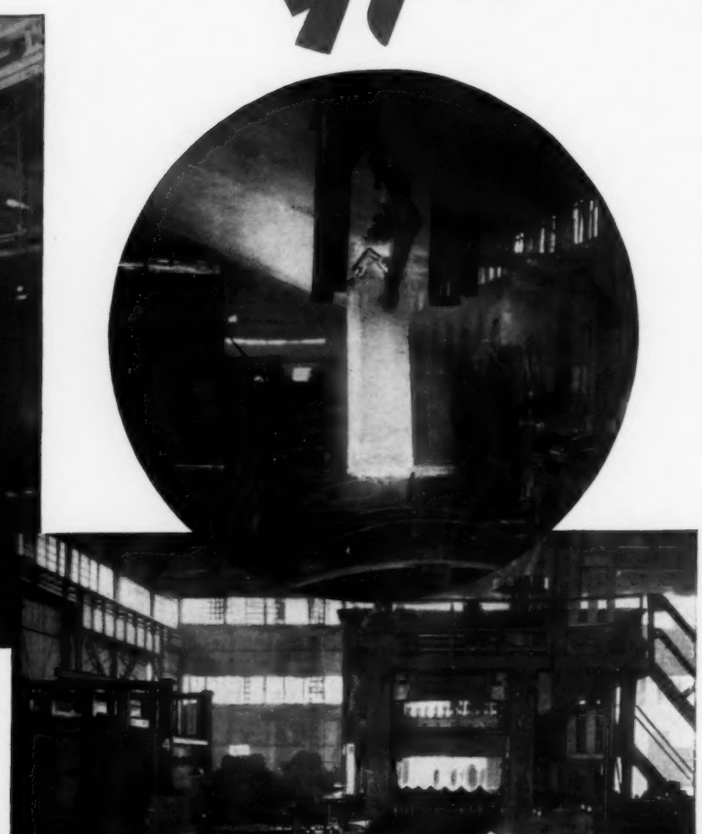
F. E. LEAHY, Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

WRAY DUDLEY, Electrical Superintendent, National Tube Company, McKeesport, Pa.

JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio.

GEO. R. CARROLL, Electrical Superintendent, Jones & Laughlin Steel Corporation, Aliquippa, Pa.

WHEN THINGS GET *Hot*



GIVE THE JOB TO DELTABESTON WIRE AND CABLE

This is good advice. For power circuits exposed to intense heat — in rolling mills, boiler rooms, soaking pits — specify Deltabeston. It's the one way you can be assured of an adequate, unbroken power supply.

Deltabeston Conductors are insulated with asbestos. But it isn't ordinary asbestos. It has been purified — contains a greater percentage of inorganic material than any other insulation. That's why, for severe applications, no other wire and cable can take the place of Deltabeston.

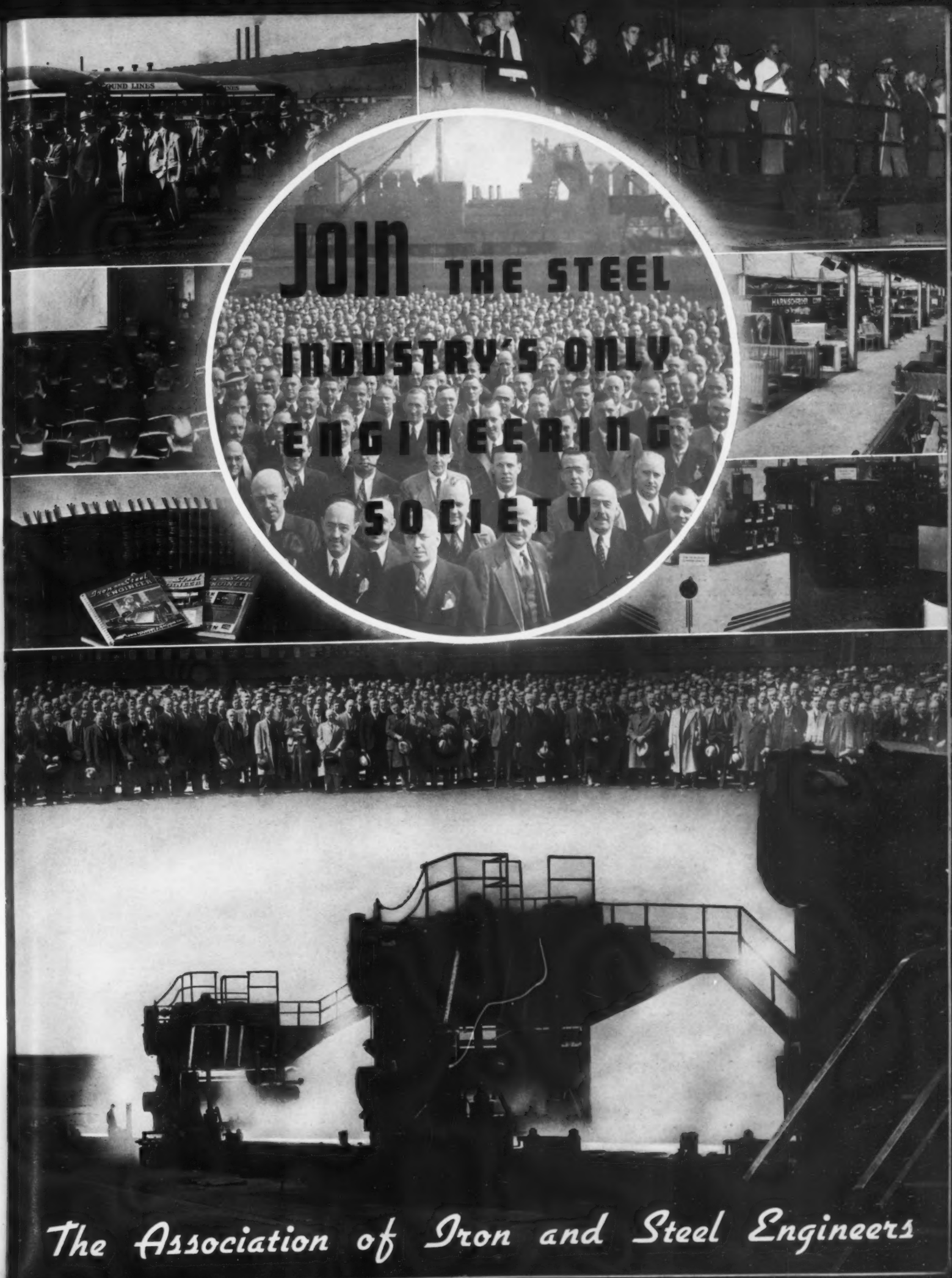
Power Cable, Magnet Wire, Motor Lead Cable, Boiler Room Wire — there's a type for every steel mill requirement. Each one is immune to the damaging effects of heat, moisture, oil and grease.

Today, write for descriptive bulletins and samples. Address Section Y-8291, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn. Deltabeston Wire and Cable is distributed by General Electric Merchandise Distributors and Graybar Electric Co.

GENERAL ELECTRIC

DELTABESTON WIRE AND CABLE

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONNECTICUT


JOIN THE STEEL
INDUSTRY'S ONLY
ENGINEERING
SOCIETY
The Association of Iron and Steel Engineers

FOREWORD

The Association of Iron and Steel Engineers, formerly known as the Association of Iron and Steel Electrical Engineers, is an organization composed of the executive and operating personnel of the Iron and Steel Industry, known as active members, and the only members permitted to vote and hold office in the society, as well as representatives from builders of steel mill equipment and manufacturers of supplies, who are known as associate members. The Association was founded in 1907, when at an informal gathering of twenty-eight electrical and mechanical engineers to inspect a special exhibit of electrical apparatus for use in iron and steel plants, Mr. James Farrington, then electrical superintendent of the Labelle Iron Works, Steubenville, Ohio, suggested the formation of a national organization of the men in charge of the electrical departments of the Iron and Steel Industry, to meet at stated intervals to discuss the subjects of common interest to electrical engineers and superintendents in their industry. The society is now starting its 31st year of service to the Iron and Steel Industry with greatly amplified activities, as it was originally found only to promote the advancement of electrical engineering in the steel industry but now all divisions of steel mill engineering, such as mechanical, lubrication, welding, combustion, and safety, are given an equal amount of attention.

SCOPE OF ACTIVITIES

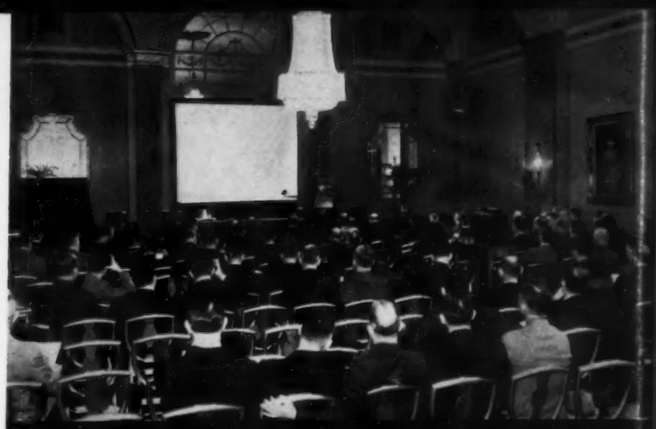
The primary function of the Association is to meet at stated intervals to discuss subjects of common interest such as latest operation practices and improved design of mill equipment. The outstanding achievement of the Association as a helpful agent is the main roll electrification of the mills. In 1907 a start had just been made and today there are over 2600 motor installations, 300 H. P. and above, totalling 4,250,000 H. P. on main roll drives. In general, it can be said that the steel mills are universally electrified. This one improvement has been the leading factor in making possible the improved mill equipment and practice of today. The continuous wide strip mill is one of the best examples of what is being done to produce a better, and more usable, and a cheaper product.

Another outstanding accomplishment of which the Association can well be proud is the work it has done in regard to the Safety Movement. The steel industry was the first to conceive the idea of safety in a broad way and recognize its humanitarian feature and its value to the employee and to the company. This resulted in the formation of safety departments starting about 1906. In 1908 the Association appointed a safety committee with the idea of fostering the movement in the general steel industry. At the banquet of the Annual Convention held in Milwaukee in 1912, the Association passed a set of resolutions recommending the appointment of a general committee to consider the formation of a national safety movement. From this has grown the National Safety Council whose great work is known by all.

The Association has sponsored several standardization programs which have resulted in a standardized mill motor for auxiliary applications and standard crane specifications. These have been of great assistance to the Steel Industry.

MEETINGS AND PAPERS

Monthly Meetings by the Association are held in the five district sections, with headquarters at Philadelphia, Cleveland, Chicago, Pittsburgh, (also national headquarters) and Birmingham. There are no sessions held during the summer of the year. A national spring conference as well as the annual convention is held each year. Over the 30 year period of the Association, 1147 authors have presented 1527 papers at 484 meetings, covering practically every subject relating to steel mill practice and management.



A total of 1527 papers have been presented before the Association covering practically every steel mill problem.

The official organ of the Association, the *Iron and Steel Engineer*, is a beautifully designed publication with a wealth of information for the steel man.

Five hundred members and guests of the Association visited this modern steel plant located in the Detroit area.

Among the activities of the Association is the sponsorship of an Iron and Steel Exposition, which is held each year.

Since the inception of the society 1527 authors have presented papers at 484 meetings.

Each member receives a year book containing all the papers published in the *Iron and Steel Engineer* during the year.

Over 100 inspection trips such as this have been sponsored by the Association during its' thirty years history.

A total of nineteen Iron and Steel Expositions have been promoted by the Association the latest of which was in Chicago.

PUBLICATIONS

The dissemination of all these papers to the members has been accomplished through their publication in the official organ of the Association, the *Iron and Steel Engineer*. This publication, beautifully designed in format and appearance, is recognized as the outstanding publication in the steel industry for the engineering and operating personnel. The editorial content of the *Iron and Steel Engineer* not only includes papers and discussions presented at the regular meetings, but also special articles relating to latest equipment and design for the industry. The most phenomenal growth of new equipment in the steel industry, developed for rolling flat steel products which has occurred in the last five years has been recorded in the *Iron and Steel Engineer*, and is recognized as one of the most comprehensive editorial accomplishments ever achieved in publishing steel mill matter. At the end of each year the members are forwarded a bound volume which contains all the technical papers published in the *Iron and Steel Engineer* during that year. This Year Book makes an attractive and useful volume for reference and library.

IRON AND STEEL EXPOSITION

The Iron and Steel Exposition held each year in conjunction with the annual Convention is an exhibit of all the latest designed steel mill equipment as manufactured by those companies servicing the industry. Starting in 1919 as one of the Association's annual convention activities, it has grown to be of immense value to both the exhibitor and steel mill operator. Both are afforded an opportunity to discuss the possibilities of better operating practices with modern equipment. The Iron and Steel Exposition is the only place where the steel mill executive and engineers may see and study all of the latest improvements and the only place where the exhibitor is assured of having a representative attendance to view his display. From a modest beginning of a few thousand square feet this show has now grown to a point where it is necessary to have over 50 thousand square feet in order to accomodate the number of displays.

INSPECTION TRIPS

It is said that there is no industry where there is such interchange of experience and personal visits to each others plants as practiced in the iron and steel industry. To a great degree the Association is responsible for such conditions as very early in its history inspection trips to various plants were sponsored by the society. Over its span of existence the Association has conducted over 100 inspection trips to practically every steel plant in the United States. This is one of the most outstanding advantages of membership in the society as it gives the members a broader perspective on their own facilities after having an opportunity of visiting and inspecting other operating procedures in various plants.

ADVANTAGES OF MEMBERSHIP

Anyone actively interested in the design, installation, operation, and maintenance of steel mill equipment whether he be employed by a steel company or a representative of a steel mill equipment manufacturer should belong to the Association of Iron and Steel Engineers. Membership entitles one to the monthly issue of the *Iron and Steel Engineer*, the official publication of the Association of Iron and Steel Engineers; also the yearly transactions, the privilege of attending all district section meetings (in Chicago, Birmingham, Cleveland, Philadelphia and Pittsburgh), the privilege of attending the Annual Convention and Iron and Steel Exposition, the Spring Engineering Conference, and the regular inspection trips to Steel Plants. These advantages to be gained from attending meetings and discussions where mutual subjects are discussed, the opportunities to develop and further contacts which will prove helpful, receiving publications and literature directly applicable to everyday working problems, attending conventions and inspection trips should not be overlooked by any one associated with the iron and steel industry. Dues for membership in the Society are $10.00 a year plus an initiation fee of $10.00. For the necessary application blank address any of the following district section secretaries:—

Birger Thele—c/o Tennessee Coal, Iron and R. R. Company, Fairfield, Alabama

W. W. Spanagel—c/o Reliance Electric and Engineering Co., 1080 Ivanhoe Road, Cleveland, Ohio

Linn O. Morrow—Schaff Building, Philadelphia, Pa.

A. J. Whitcomb—c/o Freyn Engineering Company, 310 So. Michigan Ave., Chicago, Illinois

Brent Wiley, Managing Director—Association of Iron & Steel Engineers, 1010 Empire Building, Pittsburgh, Pa.

BOARD OF DIRECTORS

L. F. COFFIN.....President
Supt. Mech. Dept., Bethlehem Steel Company, Sparrows Point, Md.

C. C. WALES.....1st Vice President
Asst. General Mgr., Algoma Steel Corporation, Saulte Ste. Marie, Ontario, Canada.

W. A. PERRY.....2nd Vice President
Supt. Electric and Power Depts., Inland Steel Company, Indiana Harbor, Indiana.

M. J. CONWAY.....Director-at-Large
Fuel Engr., Lukens Steel Company, Coatesville, Pa.

JAS. FARRINGTON.....Honorary Director
Elec. Supt., Wheeling Steel Corporation, Steubenville, Ohio

E. FRIEDLANDER.....Honorary Director
Pittsburgh, Pa.

A. C. CUMMINS.....Honorary Director
Asst. Mgr. of Operations, Pittsburgh District, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.

H. G. R. BENNETT.....Past President
Asst. General Supt., Carnegie-Illinois Steel Corporation, Duquesne, Pa.

G. R. CARROLL.....Past President
Elec. Supt., Jones and Laughlin Steel Corporation, Aliquippa, Pa.

F. E. FLYNN.....Treasurer
General Manager, Warren District, Republic Steel Corporation, Warren, Ohio

J. L. MILLER.....Secretary
Asst. Chief Comb. Engineer, Republic Steel Corporation, Cleveland, Ohio.

C. C. PECU.....Director
Lubrication Engineer, Bethlehem Steel Company, Lackawanna, N. Y.

C. L. MCGRANAHAN.....Director
Asst. Gen. Supt., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

J. A. CLAUSS.....Director
Chief Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

F. E. LEAHY.....Director
Fuel Engr., Youngstown Sheet and Tube Company, Youngstown, Ohio.

E. C. MARSHALL.....Director
Chief Electrical Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

J. F. HEADLEE.....Director
Asst. to Chief Engr., Carnegie-Illinois Steel Corporation, Gary, Indiana

J. E. HARRELL.....Director
Chief Electrician, Tennessee Coal, Iron and Railroad Co., Fairfield, Alabama.

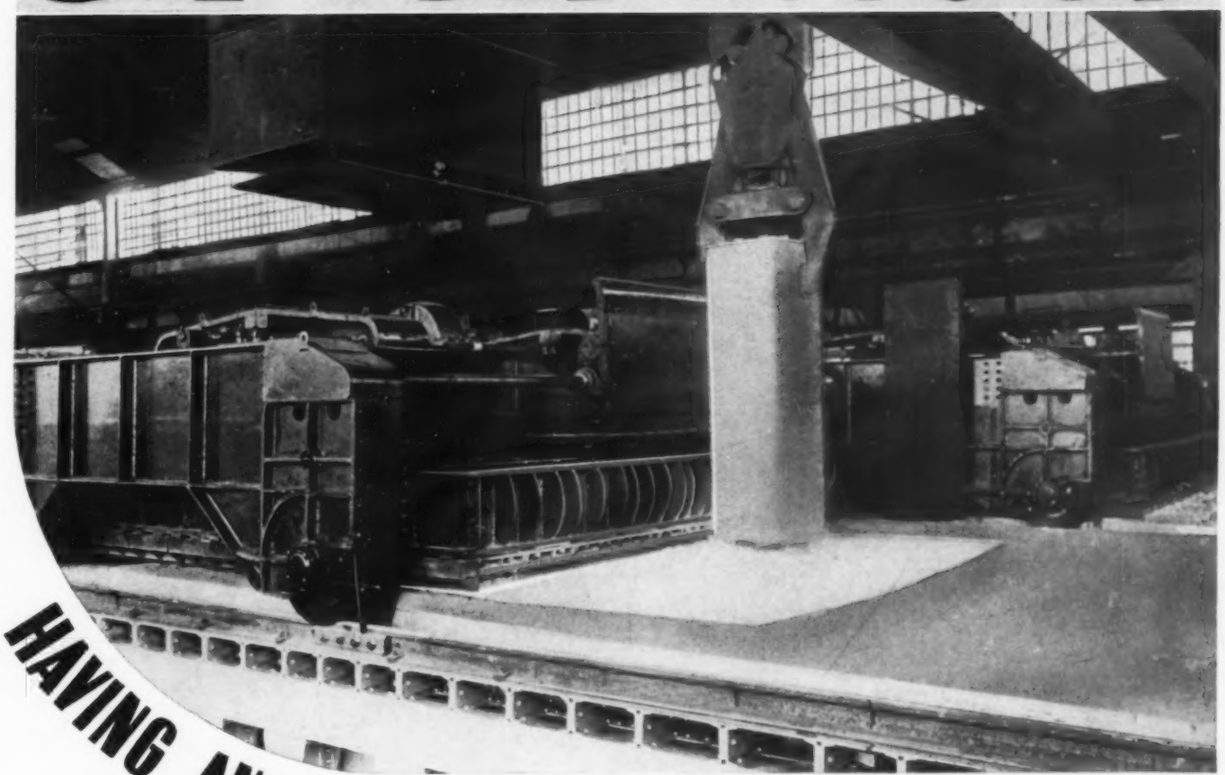
E. F. BLANK.....Director
Director Industrial Relations, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

A. W. STEED.....Director
Maintenance Supt., American Rolling Mill Company, Middletown, Ohio.

BRENT WILEY, *Managing Director*

The AMCO PIT FURNACE

37 SOLD IN 1937



HAVING AN ANNUAL HEATING CAPACITY OF

3½ MILLION TONS

The AMSLER-MORTON COMPANY

FULTON BUILDING • PITTSBURGH, PA.

Studies of

By W. A. MORTON
President
The Amsler Morton Company
PITTSBURGH, PENNA.

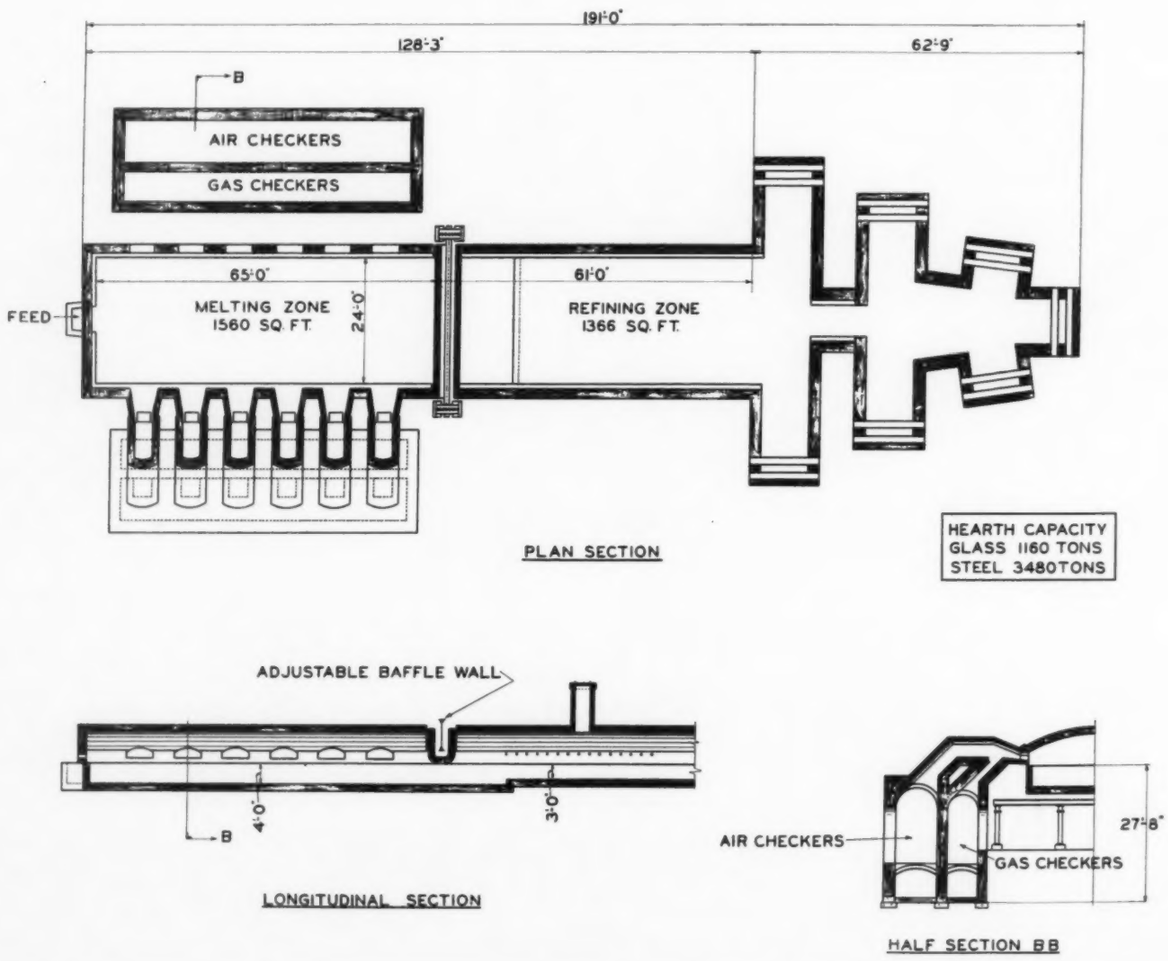
Presented before the A. I. & S. E. Philadelphia District Section, Dec. 4, 1937.

▲ THE object of this paper is to show to some extent the broader aspects of our experiences during 20 years with various types of heavy duty furnaces, and if possible, to create some new impressions by which further progress may be made by those of you who have at your disposal means to carry ideas to practical conclusions.

Industry is eagerly searching for and gradually adopting new ideas. In doing so, mistakes as well as progress are made. If more of the experience which paved the way to better understanding of the problems met in furnace design is clearly portrayed, so that these experiences may possibly be regarded as our own, resistance to new ideas may be lessened and progress hastened.

In transportation we first developed the steam locomotive, then the electric car, then the automobile, and now we have taken to the air—all to "save" time. The use of each system in its day was considered a hazardous adventure, but man eventually conquers each hazard in turn. So, we must, in a sense, gamble for every advancement in life.

Figure 1—Reversing regenerative furnace for melting glass.



REGENERATIVE *and* RECUPERATIVE *Furnaces*

We have not reached such a state of satisfaction with the design and operation of furnaces that we are willing to say that what may be sought, can't be found. Knowledge is expanding so rapidly that during a few decades we have become so highly specialized that we know little of the finer details of the art or science of our many professional brothers. It seems logical then that improvements in furnaces and furnace auxiliaries should originate with those specializing in this field.

However, I want first to point out several appropriate development experiences because they were the product of relatively inexperienced people having the talent of association of ideas, initiative and a fresh viewpoint.

Some sixteen or more years ago members of the Ford Motor organization, viewed the producing methods of our plate glass manufacturers with a feeling of contempt and were tempted to chart a new course in this field. Plate glass was being made by a system of casting and rolling which is similar to first making an ingot of molten steel and subsequently rolling it. Out of Ford's study and experiments was evolved a continuous rolling process whereby a plate glass blank of desired width was rolled directly from the molten glass into a continuous sheet. This, I understand, during the current year could have, through the present perfection of the system, produced a single piece or sheet over 500 miles long, if the material had remained uncut. Costs were more than halved. The Hazlett process advocated for direct sheet production from hot metal is, I believe, analagous to this method.

This contribution to progress resulted from a fresh viewpoint, ample capital, and ability to carry on, despite several years of discouragement.

Another example of how costs and methods are revolutionized by complete change is also interesting. It pertains to the manufacture of electric light bulbs.

Less than 20 years ago these were hand made by blowing a ball of hot glass into a mould. Thousands of men were required to produce the demand for bulbs even prior to the extravagant glares of illumination of the present.

Somewhat later engineers emulated man by making a machine which in operation was the counterpart of 24 tireless men, ceaselessly gathering molten glass and blowing bulbs. There had been no change in the method, merely in the means employed to carry out an accepted principle. The machine was extremely complicated and when compared with its successor, very slow.

About nine years ago several individuals evolved a new principle by which a narrow continuous tape of glass having thereon hemispherical protuberances was formed by passing molten glass between rolls and then while highly plastic through a machine. The hemispherical portions were then converted into commercial electric light and radio bulbs at the astounding rate of 450 to 500 blown and shaped units per minute. We find now in this country after about 7 years of expensive but worthwhile experiment, a bare half dozen machines with as many operators producing with great precision, the former work of thousands of skilled artisans and supplying our entire vastly expanded market.

Evolution in terms of the work, witnessed in these two unlike processes, stalks us on every side daily. It is expressed as complete change in the method employed to create what appears to be the near ultimate in the production of a given product from specific materials.

So we can come to a consideration of heat exchangers and furnaces for steel making with the thought that each has its good points and that new and promising principles are made available as the necessary thought and money are expended in research and experimental work.

The stimulus to development work is probably felt more by the contracting engineer than by the resident plant engineer. If he is to progress, or exist perhaps, he must create something new and improved or there are no sales. Should he have feasible plans, he then needs friendly criticism, co-operation and more liberal arrangements to make experiments or actual installations.

I have some illustrations which will show some of the types of regenerative and recuperative furnaces with which we have become familiar and others that are merely on paper.

Figure 1 is a drawing of a side port, producer gas fired, regenerative furnace melting 125 tons of glass per day and designed by us for one of the leading sheet glass producers. It is 191 feet long by 82 feet wide and 34 feet in height overall. It contains 1160 tons of molten glass and uses approximately 85 tons of coal per day. Raw materials are fed into the rear of the furnace at short intervals and the glass is vertically drawn continuously in sheet form by machines directly from the interior of the glass pool supported by the hearth. The usual operating temperature along the main hearth is 2850° Fahrenheit, but recently this temperature has continuously exceeded 2900° F. The actual melting hearth of the furnace is 25′ 0″ x 65′ 0″ and 4′ 0″ deep. The lining is electro-cast mullite costing about $200.00 per ton in place. The entire furnace would hold 3480 tons of molten steel. These figures will give you an idea of the size of the furnace by comparison with what is considered a large furnace in open hearth practice. It is characteristic of many such regenerative furnaces built by the company for melting purposes.

The furnace has approximately 20,000 cubic feet of checkers set with 6½″ square flues from ordinary 9″ brick, a standard practice of many years with us. Preheated air temperature range is from 2150° to 1980° through the 20 minute reversal cycles.

This furnace with its thirty foot long adjustable temperature controlling baffle or curtain wall, across

the furnace, and its shallow hearth to control convection in the bath, has been in use less than a year and is what might be called radical in the art. Its 35% increased daily production of improved quality glass is representative of the direct application of an idea, as versus the mere harboring of one, even though a $250,000 furnace was involved. It has the same relative place in the glass industry as a 500 Ton open hearth would have in the steel industry.

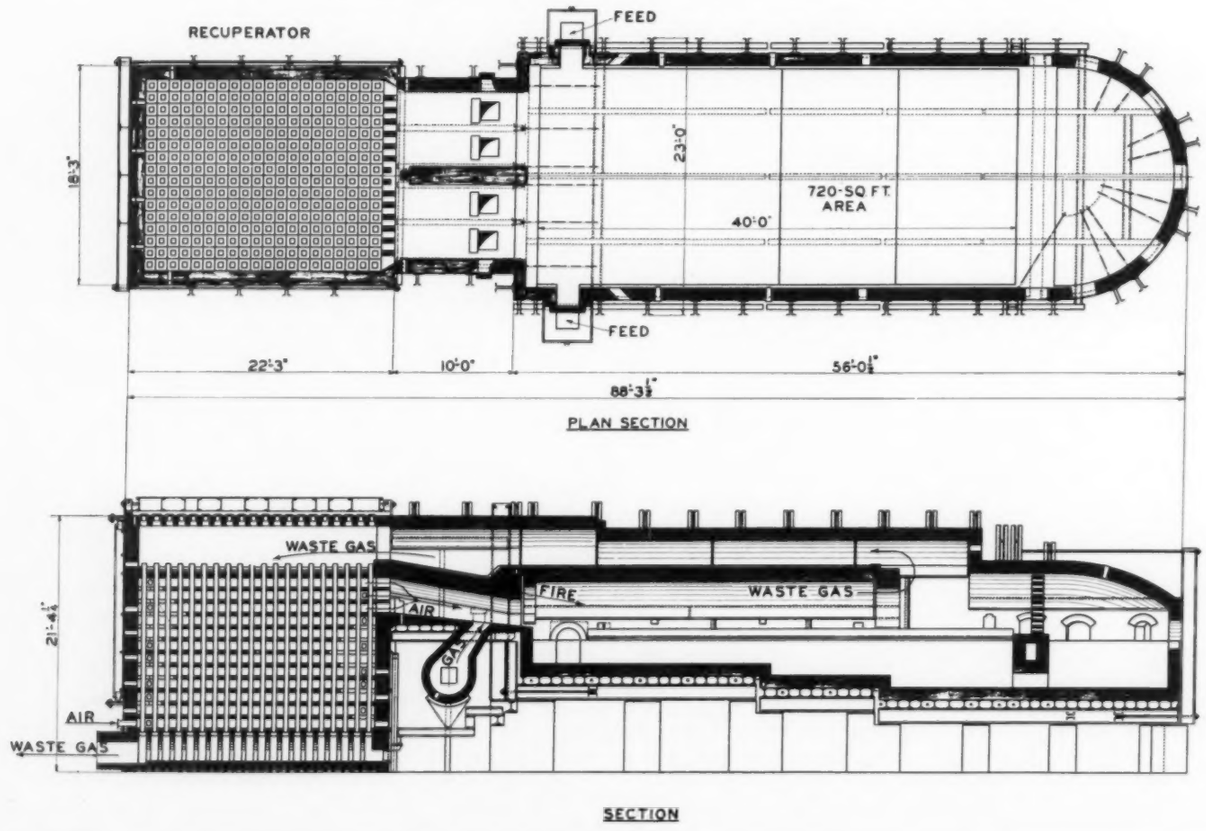
Figure 2 is a drawing of a non-reversing recuperative furnace for melting 75 tons of glass per day. It was a complete departure from all accepted forms of furnaces in the art. This furnace contains some 250 tons of glass, equivalent to a hearth capacity of 750 tons of steel. It occupies a space 23′ 0″ by 88′ 0″ and is one of the largest recuperative furnaces in existance operating at elevated temperatures. There have been no repairs to the recuperator during the 3 years of its operation. The furnace compares with a regenerative furnace in the ratio of 260 to 500 square feet of space required per ton of product produced.

It melts a ton of metal with .25 to .3 ton of coal as compared with a requirement of .39 to .5 ton by the best regenerative types.

The producer gas is not preheated but is received at about 700° F. and applied in a series of inlets in the bottom of the air ports. The combustibles are projected into the furnace at a velocity of about 30 feet per second and a metal temperature of about 2800° F. is constantly maintained. Raw materials are charged and metal is removed continuously, the level of metal in the hearth being unchanged during its continued operation.

You will observe that the furnace has two spring silica arches, the upper one spaced about 18″ above the lower. It might be mentioned that dire failure of the inner one was predicted, without considering the fact that silica retains its rigidity until its fusion point is reached. The space between the arches becomes the passage for the continuous removal of the waste gases. This communicates with the distributing chamber over the recuperator cell at the rear of the furnace. Waste gases pass directly downward through the tubes and air is moved vertically in a series of horizontal passes. The flat arch is perforated in alignment with the tubes, to permit the use of a cleaning implement for the removal of dust. Ordinary refractory material is em-

Figure 2—Amco Non-reversing recuperative furnace for melting glass-double crown.



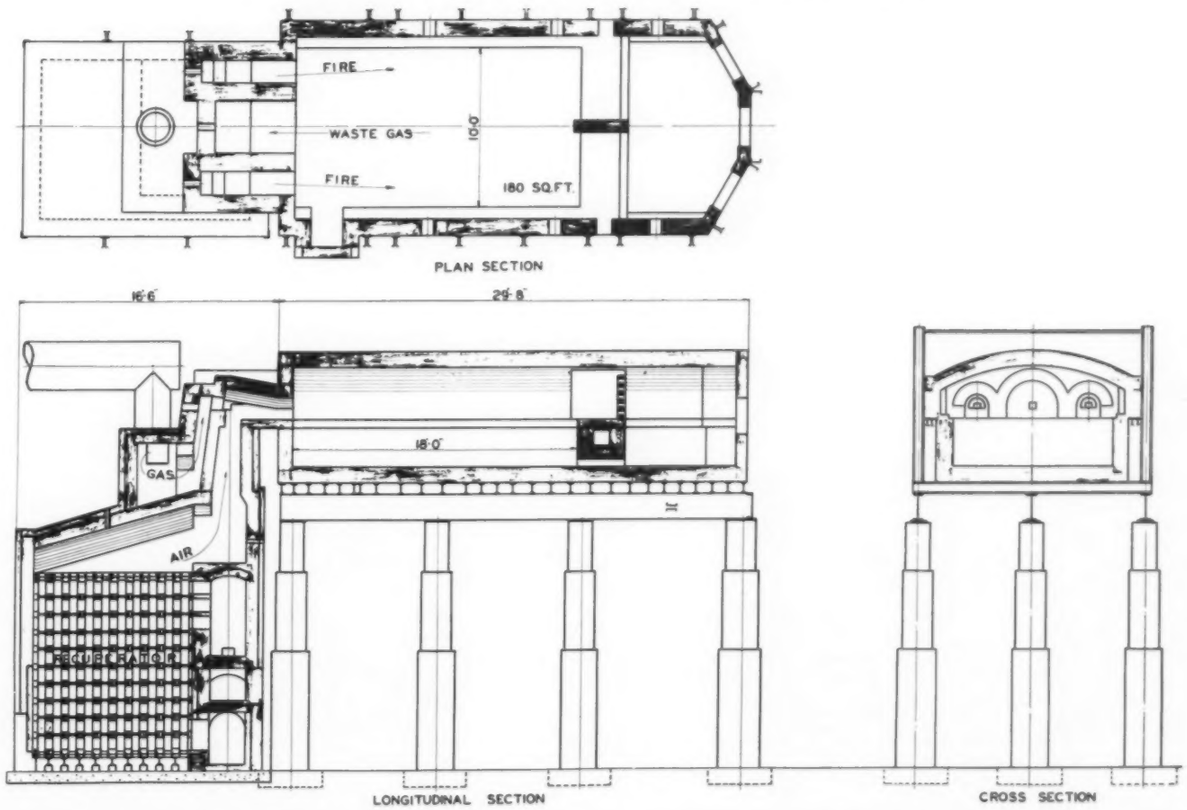
ployed in the tubes of the lower passes and an "electrocast" material having zero porosity in the zone of highest temperatures. Preheated air temperatures equally as high as the average of a regenerative cycle are obtained. In this recuperative furnace, and similar ones melting silicate of soda, air temperatures of 2150° F. are customary. This is due in part to the high conductivity of the material in the final air pass, in part to moving the waste gases through the recuperator out of contact with the enclosing walls, but also because of the compactness of assembly of the heat exchanger and furnace. The counterflow connections between the furnace and heat exchanger are but a fraction of the length usually required with regenerative designs and are in heat exchange relation. We consider this one of our best designs, because of its extreme simplicity, although it was originally considered very radical.

This form of furnace is successfully used for various commercial glasses. When used on furnaces melting certain special glasses, solids which are difficult to remove the operation of the furnace, accumulate in that portion of the recuperator where the temperature within the tubes drops to about 1600° F. So this furnace and its principles, while ultra economical in fuel consumption, and relatively inexpensive to construct, is limited to those applications for which it is adapted. It undoubtedly has not as yet reached its best field. At present, experiments are being conducted which may eliminate the single operating problem peculiar to this design and extend its apparent benefits and use.

Figure 3 shows the forerunner to the preceding design of non-reversing recuperative melting furnace. The recuperator was similarly located, but the double arch feature is lacking. Fuel was applied at the corners of the hearth, and waste gases removed through the center port. This furnace had an outstanding defect, namely, the partial diffusion of the unburned combustible with waste gases, caused by the counter flow of the adjacent gaseous streams and resulting in poor flame direction and lowered flame temperature potential. There was excessive erosion of the waste gas outlet and overloading of the heat exchange system with waste gases excessively heated by radiation, and also delayed combustion from the gases mixing from the adjacent ports.

The experience with this furnace was valuable in determining the more rational subsequent designs and

Figure 3—Amco non-reversing recuperative furnace for melting glass-single crown.

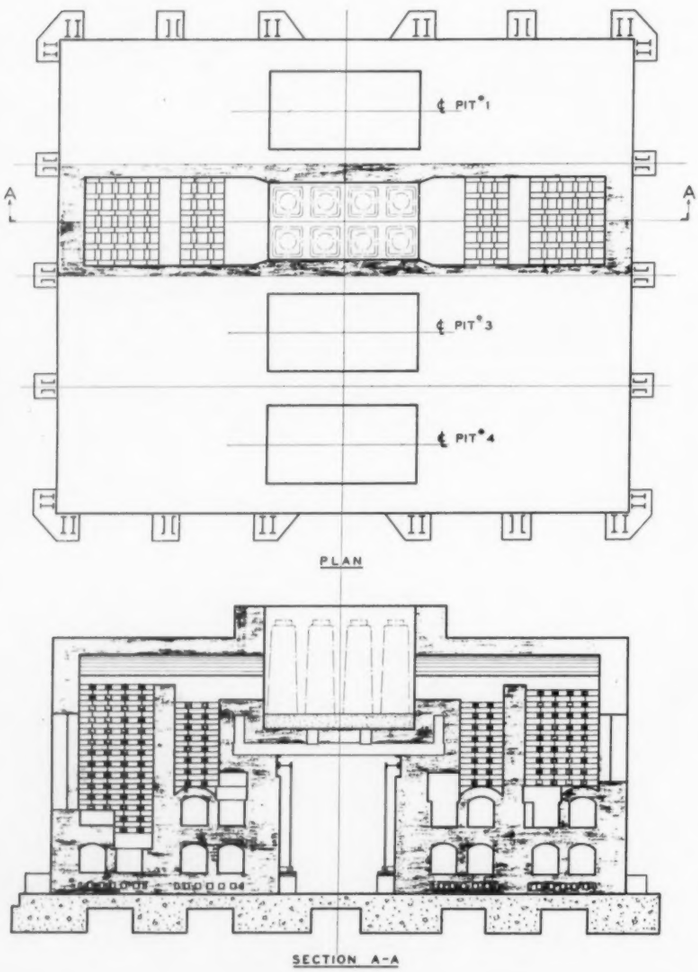


should be useful in the consideration of new designs.

I shall now describe the application of regenerators and recuperators to certain steel furnaces.

Figure 4 shows a typical existing reversing regenerative furnace for ingot heating. The plan view reveals the absence of a definite and adequate combustion space within the pit. The furnace, when charged with hot steel, is usually filled by the ingots, and space for gases to move and burn properly between the ingots is very limited. The omission of the combustion chamber is evidenced by the usual procedure of greatly reducing the charge of steel in the pit when heating cold ingots, to provide the space required for the higher fuel rates necessary when heating cold steel. The interference with the natural flow of the combustible by placing ingots in what should be the path for the flames when a full charge is present is neither sound for good combustion or correct heating. Unnecessary washing, bottom making, fuel consumption, and excessive complication of structure are weaknesses of this very common type of regenerative furnace,—especially with high B.T.U. fuels.

Figure 4—Reversing regenerative furnace for heating ingots.



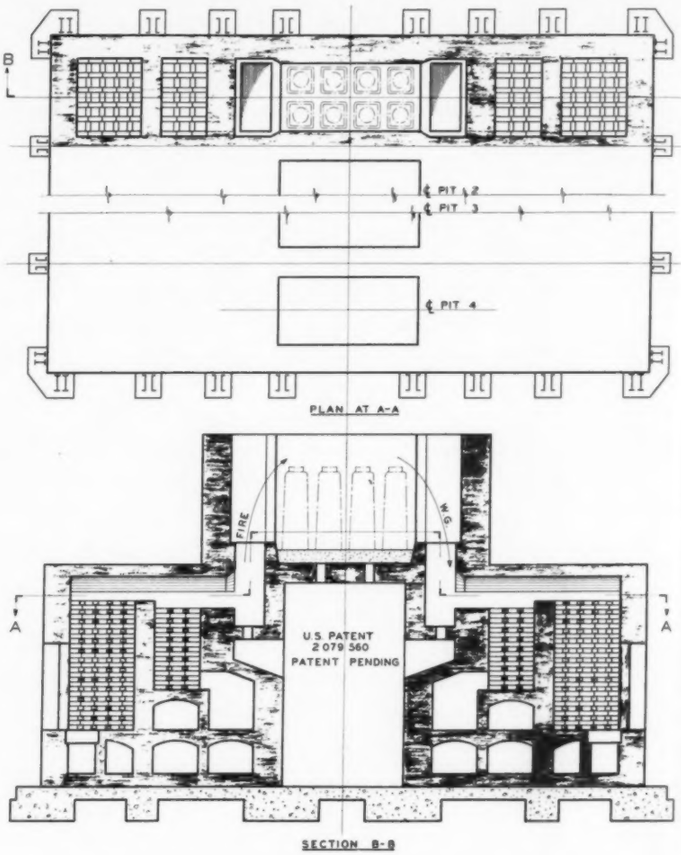


Figure 5—Amco reversing regenerative furnace for heating ingots.

Figure 5 is a drawing which shows the proposed design of a newly patented reversing regenerative ingot heating furnace. A definite combustion space is provided and flame direction varied from the usual regenerative practice by moving the dual purpose port to a new position at the hearth level. This location of the ports in a regenerative pit furnace may at first be considered a waste of space that might be used for production; but, since fuels other than producer gas are more commonly used for pit furnaces, the space occupied by the gas regenerator may be used for this purpose.

The important improvement over ordinary practice would be the provision of a definite space adjacent the ingots, into which the flame may be directed without impingement upon the ingots and which is of such size that more fuel may be burned and heavier charges heated, than in most current practice.

The natural velocity head of the air from the regenerators is increased by adding the depth of the pit to the column of burning combustible. The addition to this natural force is very useful if a uniformly heated environment is to be created about long pieces of steel standing in a deep furnace. The effect of increased turbulence or circulation or furnace efficiency shall be shown later. This furnace would not wash steel to the extent of the ordinary regenerative pit, therefore there will be fuel, labor and some product savings by elimi-

nation of the waste which accompanies washing. The many wastes resulting from washed steel have been generally considered necessary evils. They may amount to more than 25c per ton of steel.

Figure 6 is a section through the non-reversing Amco pit furnace for heating ingots, revealing the method of firing and the general similarity to the accepted form of the regenerative furnace. A paper describing the pit, and the Amco recuperator developed for this furnace, was read about a year ago at Detroit, but we would not be responding to our subject if we omitted reference to the subsequent progress of this pit and the recuperator.

Unless otherwise stated, we will deal solely with operation on blast furnace gas.

A newly installed group of these pit furnaces with recuperators is successfully heating cold ingots at satisfactory rates using cold 90 B.T.U.b last furnace gas fuel. Preheated air temperatures with hot steel have ranged, during the progress of a heat, from 1900° to 1950° F. Steel is drawn when couple located in waste gas flues outside the pit proper reads about 2300° F. The B.T.U. rate per ton of cold steel heated is 1,800,000 and 375,000 on hot steel. For one week heating 73.5% hot steel the overall rate was 900,000 B.T.U. This last figure is also the observed B.T.U. rate of the Amco pit when heating cold steel in 5.75 hours with coke oven or natural gas. Converted to a constant these rates may be interpreted into an average rate of 155,000 B.T.U. per ton-hour of heating time. The B.T.U. rate with blast furnace gas is higher than with natural gas due to the excess weight of waste gas accompanying the fuel. The efficiency of the pit furnace on high B.T.U. fuels is about 45% and the theoretical efficiency using cold blast furnace gas is 24%, but in practice this is raised to 32% by the extremely active fluid motion within the pit when using this fuel; preheating of the gas would result in raising the efficiency to about 36%.

Lower fuel rates and improved heating of ingot butts are the result of the elimination of washing and many new cold pit bottoms. The periods between bottom making are now extended to from one to two week intervals. Fuel rates take a sharp upward trend as the percentage of down time for cleaning increases.

The sole change in the construction of the furnace for the added use of blast furnace gas was a by-pass connection between the distributing chamber at the top of the recuperator and the chimney flue to control waste gas and air temperature differentials at the base of the recuperator to prevent excessive tension stresses in the tile. Trinks gives the maximum permissible product of tg-ta x S(Tile Thickness in inches) as 1200. In the modern Amco recuperator this is but 300 to 400; or the strength is over 3 times as great as is generally considered good practice. Waste gas leaves the recuperator at about 800° F., but, when mixed with that from the by-pass, shows a temperature of 1200° F. going to the stack. The average of a series of flue gas analyses is as follows: CO_2—25.5, O_2—.6, CO—None.

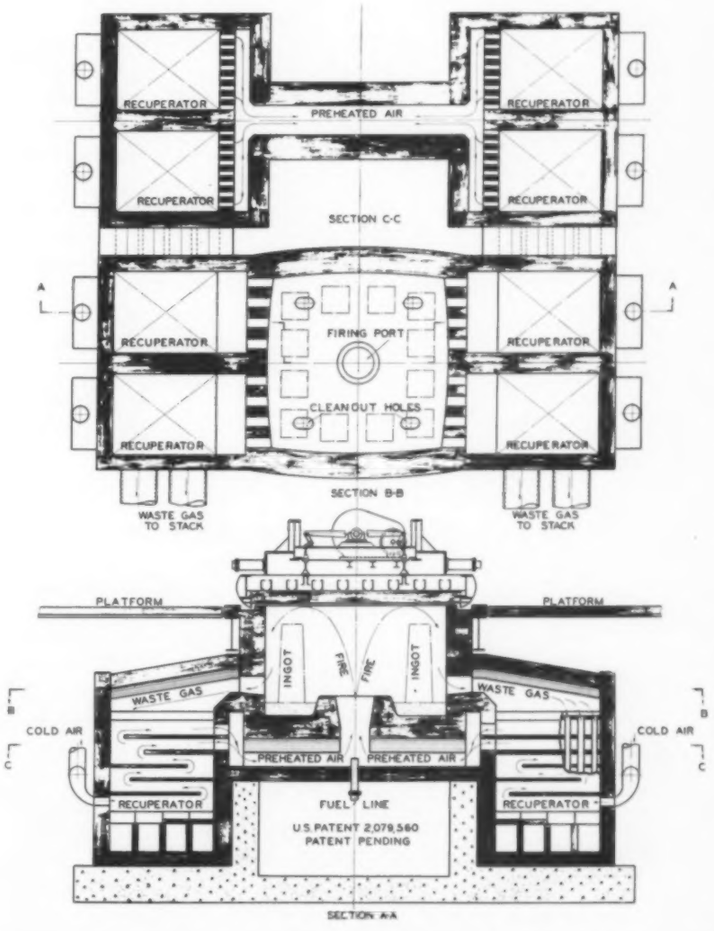
Cold ingots 20″ x 20″ are now heated and properly soaked in a period of 8 hours or several hours less time than in existing modern regenerative pits in the same plant. The soaking period is that observed portion of the heating cycle extending from the time of initial automatic fuel cut back as saturation approaches completion until the rate of fuel flow levels off to merely sufficient to supply stack and radiation losses.

At the conclusion of this recorded period it is obvious that the steel and refractory saturation of all walls is complete and therefore successive charges of cold steel may be heated without impairing the rate, or quality, of heating. Without automatic control this condition can not be reliably repeated.

It may be noted that these pits were designed for the heating of 12 ingots and that the above fuel figures are based on heating 16 hot or cold ingots. This represents 29% more tonnage than was planned and is in direct contrast to the accepted practice of reducing the load when heating cold steel in regenerative pits. The advantage of an adequate and suitable combustion chamber is clearly shown by the heating rates on cold steel. With 12 ingot charges 4.5 tons are heated per hour; with 16 ingot charges the rate is 5.3 tons per hour depending of course upon the size of the ingots; and the observed B.T.U. rate on cold ingots is 1,480,000 per ton.

In this era of automatic control the larger pits, or the fewer for a given tonnage we might say, have definite investment advantages over the small holes. The same control equipment will regulate a pit containing

Figure 6—Amco non-reversing recuperative furnace for heating ingots.



either 4 or 16 ingots. In large projects this is favorable to the more recent trend to large pit furnaces.

These pits heat more steel in the manner in which it may be heated while they maintain fuel rates and pit temperatures as required to control the maximum permissable ingot surface temperatures. The extremely high air preheat temperature is the sole reason for what is believed to be the first successful use of 90 B.T.U. cold blast furnace gas on a one way or recuperative pit furnace.

A point which should be made about recuperators in general is that the selection of materials and the form of application to a batch type furnace presents a different problem than selecting a design acceptable for a continuously charged furnace.

Unlike most others, the Amco recuperator as applied to the pit furnace, is divided into a series of relatively small cells, thereby greatly increasing the enclosing wall surfaces. This additional refractory material acts as added heat storage capacity which provides a regenerative effect during the period following charging when the weight of air to be heated, and the demand for high preheat, are greatest. This reserve storage of heat, which is about equal to 75% of normal regeneration added to the large sensitive tube surface, aids the recuperator to stabilize air preheat temperature in a narrow range throughout the heating cycle imparting extremely fast working qualities to the furnace. This shall be shown.

It will be observed from the graphs on Figure 7 that the air temperature fluctuation through a heat is in the order of 50° and that this rate of fluctuation is much less than the rate of temperature change in the furnace. As a result, furnace temperature control is simplified, heavier cold charges may be made, and greater economy procured, as shall be shown later.

The somewhat larger recuperative surface and enclosure incident to the use of clay tile in cellular design appears to find its best place in the batch type furnace, of which the pit and open hearth are representative. When coupled with radiation "spontaneity" and planned reserve, an ideal heat engine is created.

As is the case in so many engineering problems, the development of the Amco recuperator was dependent to a large degree upon the development of a material suitable for the purpose.

The requirement is an extremely dense durable material, that is stable in thin sections to increase heat transfer, and make the recuperator more sensitive than formerly to radiation, which, of course, is more effective for the purpose than conduction. The term "chinaware" once was derisively coined by a soaking pit operator for our recuperator tile but the particular recuperator in question has successfully withstood a series of floods, nearly two years of intermittent pit operation, and is heating more steel now than at any previous time since it was built.

The appellation, "chinaware" was more appropriate than our skeptical critic knew. The experimental and development work that produced the "body" for this tile was conducted almost entirely in the ceramic industry, but not with recuperators. Here again we see the possibilities of the benefits to be derived from experience in industries other than our own.

I have the following notes from the maker of this exceptional material:

> "The development of an inexpensive refractory body capable of withstanding repeated thermal shock was much sought for by refractory producers everywhere. The desired result had been approximated by very expensive materials such as silicon carbide, the production of which however possessed certain manufacturing problems in addition to high cost. This material is exceedingly difficult to work, being non-plastic, and like electrically fused and cast mullite, it was impractical to produce thin sections at costs that would create a substantial volume market. Another and perhaps the chief impediment to the use of silicon carbide is the fact that oxidation occurs at temperatures from 1800° to 2200° F."

The ideal body for heavy duty furnaces operating with waste gas temperatures above 2400° must be free from chemical and physical change. Such a material had been developed and was being used in saggers for firing china at 2450° F. These thin receptacles were employed under combined load and temperature conditions that never would occur in recuperators and were giving the astonishing service average of 250 heats. That is, they were cooled to atmospheric temperature, and actually handled, loaded and returned to the kilns 250 times. These bodies have a coefficient of expansion of 24 x 10^{-7} when heated from 70° to 1600° F. The cold modulus of rupture will average 2400 pounds per square inch. This compares with a coefficient of expansion of 35 x 10^{-7} and a cold modulus of rupture of 700 pounds for ordinary refractories manufactured by the same company.

The other item of importance is the firing which is at 2550° F. This firing is controlled to complete the bonding reactions and produce a material having a straight expansion curve. The point of inversion of the quartz under these circumstances will not show any appreciable volume change and therefore the stresses that cause cracking are not set up.

Until quite recently such materials were only produced in the laboratory with varying results. Most of them did not have the necessary working properties to permit their production on a commercial basis. Now we can make recuperator tubes for example by tamping, slip casting, and extrusion, in wall thicknesses as low as 3/8 of and inch.

We then have available for recuperator service a material having the following properties:

1. Adequate refractorieness at most service temperatures.
2. High resistance to thermal shock.
3. No shrinkage or growth.
4. Extreme sensitivity to radiation.
5. Working properties permitting the manufacture of pieces to close dimension tolerances.
6. Relatively low cost when compared with electric furnace products such as fused mullite or silicon carbide.

If a small recuperator cell constructed with material of high conductivity is applied, for example, to the batch type furnace, the entire load of heat recovery and potential pre-heat temperature is thrown upon the tile

tubes. After charging, the furnace may cool 200° to 500° F. or more. But the highest fuel rate is demanded immediately following charging when the waste gas temperatures are materially lowered by the passage of the flame through the relatively cold furnace. The increased air flow extracts the sensible heat from the limited walls and recuperator surfaces; air preheat diminishes; flame temperatures continue to fall; and this process of heat loss from the inadequate recuperator to the furnace continues until a balance is restored when preheat is gradually increased and effective heating of the charge, furnace and recuperator commences.

In hydraulics we can increase the pressure and obtain more work from a given unit. It is not possible to increase preheated air temperature beyond a certain optimum by merely enlarging the heat exchanger. The temperature within the heat exchanger must be increased as shown in Graph I. Therefore, if a design of recuperator is adopted which will produce higher initial and sustained flame temperatures under load demand in the batch type furnace, much time and therefore fuel may be saved.

In the early types, and all present day recuperators, waste gas flows around the tubes conducting the air to be preheated. In such designs the air is in contact only with the tube walls—so we have true recuperation, with air temperature limited to the radiation and conductivity of the tubes.

In the Amco recuperator waste gas flows through the tubes and heats the walls of the enclosure as well as the walls of the tubes. Air circulates about the tubes and the method of the recuperator exists; but the air also wipes the substantial wall surface of the cell and the method of the regenerator also exists simultaneously. Here we add the steadying influence of heat extracted from the walls to that which is normally given up by the tubes, as shown by the operating data plotted on the illustration.

The lack of a better understanding of the possibilities of securing this added heat recovery and elimination of temperature shock in continuous heat exchangers, when applied to furnaces receiving sudden loads, is partly responsible for a great deal of criticism hurled at recuperators in general; but the design and materials used together with the usual problems of selection of specie also played a heavy part.

The following figures have been prepared to reflect the advance in pit furnace practice made possible by first class recuperation applied to the furnace:

TABULATION OF OPERATING DATA ON AMCO RECUPERATIVE PIT FURNACE COKE OVEN GAS FUEL—O. H. STEEL

(Monthly overall fuel rate—570,000 BTU per G. T.)
Based on 1—hole heating *75,000 gross tons of ingots* per year.

Observed Economy Schedule (Per G. T.)

Fuel (750,000 B.T.U.)	$ .15
Coke 26.5 lbs.	.0023
Labor	.013
Scale (1%) (22.5 lbs.)	.004
Conditioning	.15
Power	...
	$ .3193
Saving per ton of steel	$ .3193

Saving per year 75,000 x .3193 = $23,947.50

Maintenance Schedule (cost per G. T.)

Cover (1 yr. basis)	$ .0172
Port (1 yr. basis)	.0038
Pit relining (1 yr. basis)	.016
Outlet ports (1 yr. basis)	.0014
Recuperator (3 yr. basis)	.0086
Maintenance per gross ton	$ .047
Total yearly maintenance	$ 3,525.00
Investment	75,000.00
Annual Economy	20,422.50
Amortization rate in years	3.67
Earnings percent annually	27.2%

These figures are based on observations in the field and are a reasonably correct indication of the advantages of an investment in modern furnace design.

Figure 7—A series of consecutive heats showing preheated air temperatures obtained with Amco recuperator applied to pit furnace using blast furnace gas.

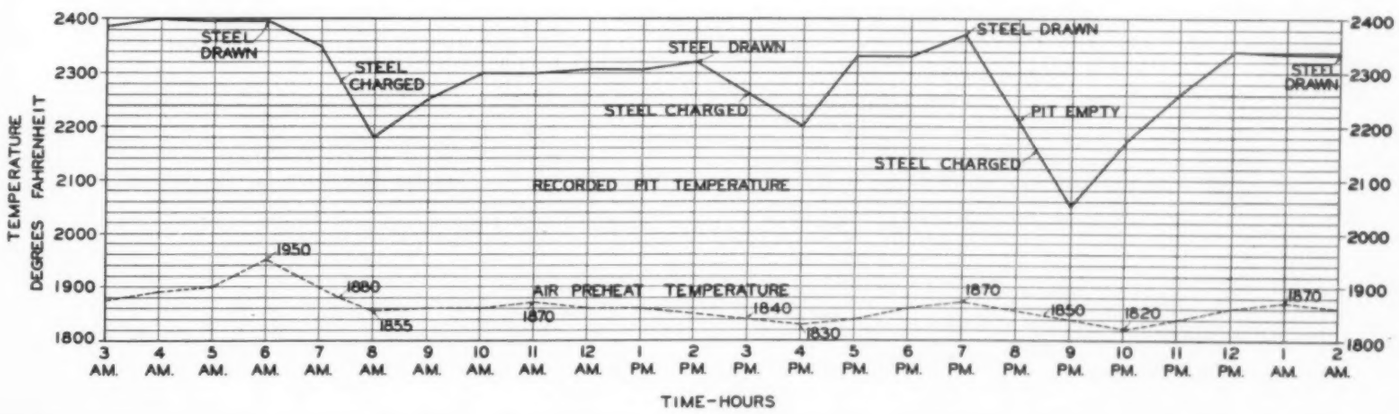


Figure 8 shows a form of proposed non-reversing recuperative open hearth furnace suitable for 50 to 75 ton sizes in which the firing is continuous from one end of the hearth to the other. The chief advantage is complete combustion control through the medium of specifically designed burner and outlet ports. This results in faster heating by increasing the rate of combustion in the initial stages of heating when the furnace is cold. Intimate mixing of fuel with regulable quantities of air by means of the more closely calibrated burner port is an important asset afforded only in simple form by the non-reversing recuperative system.

A valveless furnace of this type in a 50-ton size will save about 350,000 gallons of water per day and should, with proper recuperation, show fuel economy in the order of 15% or 20%. The fuel economy for the present must come from time saved, slightly increased hearth area, better combustion with less excess and infiltrated air, and reduced radiation losses.

The recuperators are placed in any suitable position as near as practical to the outlet end of the furnace. This will require rather extensive flues for delivering the preheated air to the furnace, an undesirable but apparently unavoidable condition in this design.

In the combustion controlled uniflow furnace, air is supplied by a fan but the pressures prevailing within the recuperator need not be higher than those within the soaking pit recuperator which are about .05″ to .07″ of water.

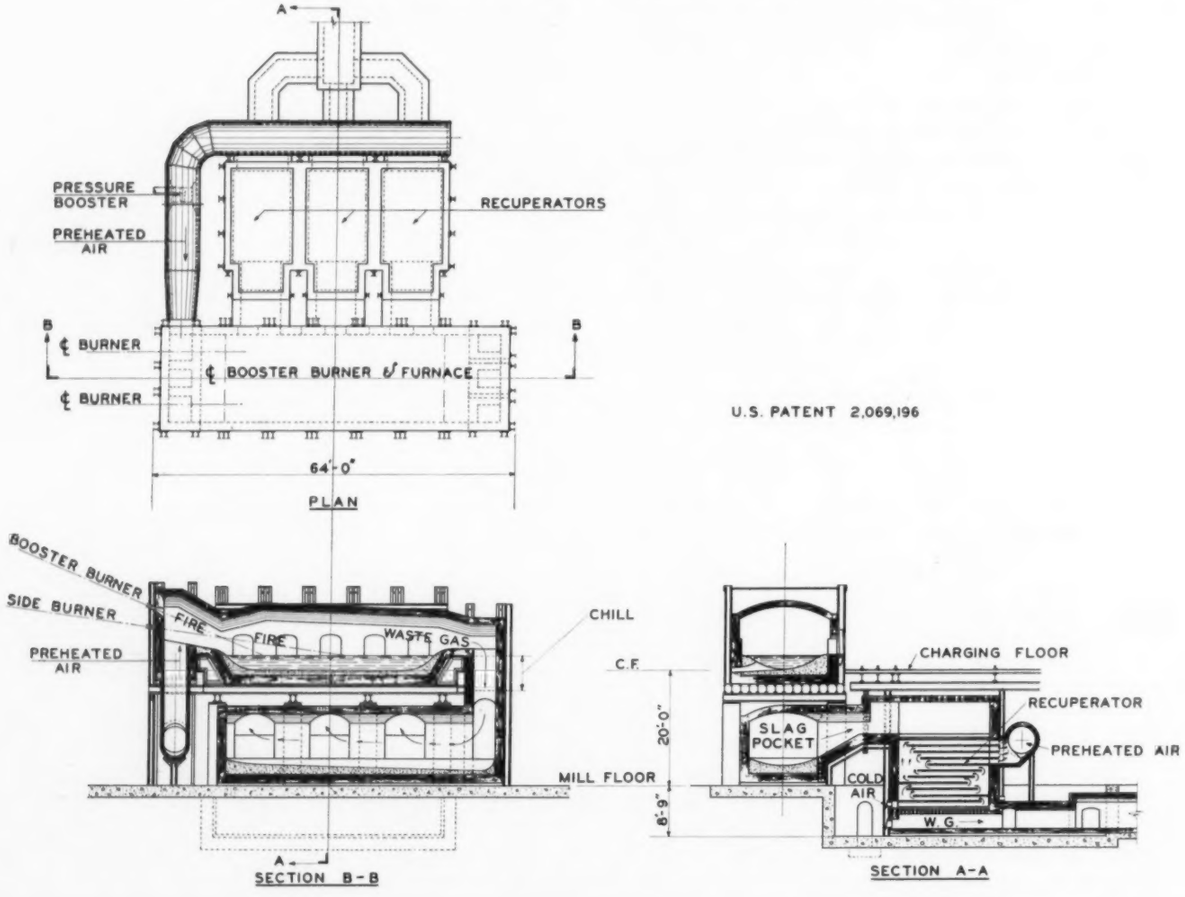
In the preheated air duct leading from the recuperator to the furnace, in this design, there is provided automatic means in the form of a controlled aspirator to balance a desired pressure within the recuperator under all conditions affecting the operation,—such as unusual resistance occasioned by fitting the furnace to an existing layout, or by the accumulation of furnace dust within the recuperator flues. This device would lend speed to heat recovery in the hearth, by controlling the port velocity. About 10% of the total air would be introduced in this way into the air flue at about 400° F.

Most open hearth settings provide ample natural head to impress the preferred port velocities upon the gases. These may be in the order of 40 or more feet per second depending upon the length and width of the furnace which will determine the kind of flame and number of burners that must be employed.

I believe Mr. Conway may have some further remarks on this furnace, the design of which was patented by him, so we can pass on to the concluding illustration.

Figure 9 which shows a proposed furnace of the non-reversing type differs from the previously described furnace in several respects and is suggested for larger

Figure 8—Non-reversing recuperative open hearth furnace fired at one end continuously.



furnaces than the single burner type. It is fired from both ends continuously with outlets parallel with each inlet, and so spaced and arranged, that they may be located substantially in the space provided by the sloping backwall.

While we are on the discussion of outlets for high temperature recuperative melting furnaces, I am again going to call your attention to Figure 3. As you may now recall, it is one of several furnaces that had the central outlet port with firing ports on each side and caused a great deal of trouble which was only eliminated by the more rational plan of removing waste gases out of the path of the incoming combustible.

We will now refer to Figure 8 which reveals that this furnace has the more ideal arrangement of inlet and outlet. No unidirectional fired melting furnace can create a lasting place in industry if there is serious diffusion between combustible supplied and the waste gases.

It will be observed from Figure 9 that there is a liberal spacing of the inlet and outlet ports to prohibit diffusion between the several gaseous elements involved in the continuous operation of the furnace.

The object of firing from both ends is not so much out of choice, but of necessity, to adopt definite improved principles of extremely fast heat exchange to the open hearth in the rather fixed form in which it is found.

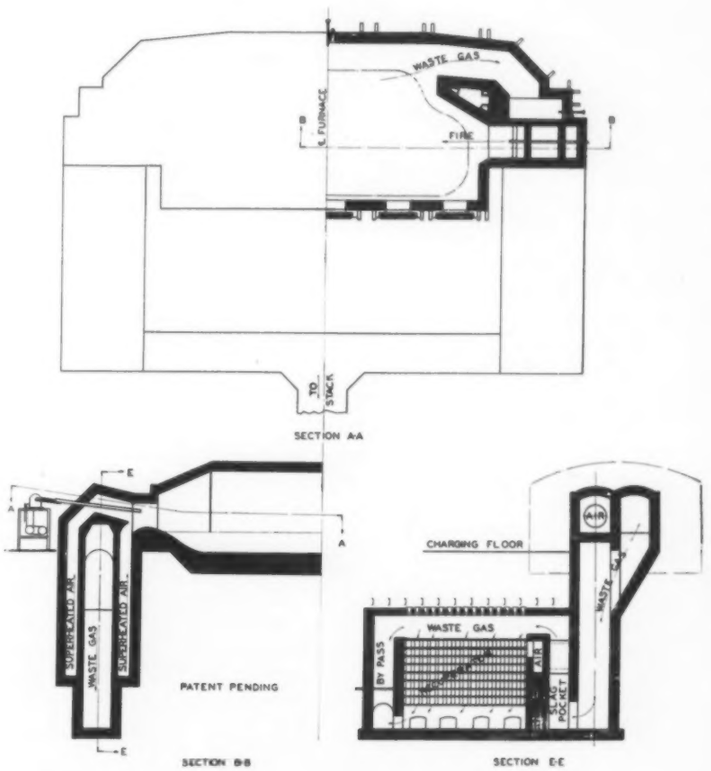
If we are to obtain appreciably higher air preheat temperatures for unidirectional firing of furnaces requiring high flame temperatures, we must employ improved methods of accomplishing this. You will observe that the waste gases are removed continuously from each end of the furnace and that the preheated air from the recuperators rises continuously on each end. The usual loss by radiation occasioned by the transportation of preheated air through extensive flue systems is absent.

We are seeking to deliver the preheated air at the highest possible temperature to the furnace, especially during the initial stages of the heat, to advance the rate of reduction in the furnace. To accomplish this, we now propose what is termed an "Air Superheater". It has two functions,—mass storage of heat and continuous transfer of heat, in an area where the waste gas temperatures are greatest. Tests made on a small commercial furnace of this design operating at plus 2900° F. showed air preheat temperature of 1750° F. out of the recuperator and 2150° F. out of the superheater.

The correctness of these temperatures may be questioned, but a drop in the waste gas temperature from 2800° F. to 2200° F. occurred simultaneously and, as the latter could be measured without the influence of radiation from the furnace, there is every reason to accept the data as being sufficiently accurate for the purpose. Assuming that it is true, a great quantity of heat was being transferred by radiation through the walls of the superheater which are at extremely elevated temperatures.

The air superheater will make it convenient to apply flames of equal temperature continuously to each end of the hearth at velocities in the order of 90 feet per second. The rate of reduction of the charge may, thereby, be greatly advanced with a corresponding saving in fuel and increased output from the furnace. High melting rates and fuel efficiency are being obtained in regenerative open hearth furnaces having adjustable ports where such velocities are developed. It is estimated that air may be delivered to the superheater at temperatures in the order of 1900° F. and that final preheat of 2200° F. is possible for the recuperative open hearth. Studies are now being made of various materials to determine their suitability for load, temperature and corrosion resistance, but silica brick will serve until something better is found. No special refractory other than sillimanite is necessary in the recuperator structure itself when the superheater is employed. The superheater is not new, having been applied successfully to a series of furnaces starting about 8 or 10 years ago. The necessity for this device was created by the request of one of our largest and best known glass factories, for an inexpensive heat exchanger for an experimental furnace to be operated at much higher than ordinary temperatures, for the melting of special high silica glasses for X-Ray tubes. The ordinary recuperator application of clay tile as of that period would have failed in a few days, whereas the superheater conceived to meet the problem, reduced the temperature of the flue gases entering the recuperator and so an experimental furnace became an immediate success and a source of repeat orders. It furnished

Figure 9—Non-reversing recuperative open hearth furnace fired at both ends continuously.



some valuable experience which may now be applied to other work to which it appears adapted.

An open hearth furnace of this design would have some unique control features. The first would be the use of automatic furnace pressure control at the head of each outlet to provide a uniform flow of waste gases to each recuperator, thereby insuring equal flame temperatures on both ends of the furnace.

Wide variations in air preheat and air weight, and therefore flame temperatures, is one of the disturbing factors preventing automatic temperature control when applied to conventional reversing regenerative furnaces, from reproducing the ideal smooth temperature and combustion conditions obtained from the well balanced recuperator application.

The second control feature on the proposed furnace would be automatic temperature control at the head of each outlet adjacent the pressure control unit,—each control functioning to regulate the fuel and air to its respective burner or burners.

The third feature deals with the burners. These would be mounted with means for timed mechanical position change in the ports during the progress of a heat; thereby, controlling the rate and character of combustion throughout the cycle with particular attention to hastening the rate by raising flame temperature while the charge and furnace are cold, and gradually extending the range of thermal release progressively as the portions of the charge in proximity to the furnace terminals are melted.

We might magnify the true relative effect sought for by comparing the relation of the natural burning of oil on a saturated wick with the oxy-acetylene burner in which mixing of the combustible is paramount.

While this method of burner application could also be employed in the regenerative furnace using liquid and certain gaseous fuels, it obviously would lack the advantage of correct port calibration and the benefit of simultaneous melting rates at each end of the furnace. The use of two burners means higher and more uniform terminal temperatures, because thermal release is faster from two burners than one when both are correctly applied.

Before terminating these remarks which I believe Mr. Bradley will augment, it may be timely to mention the advantages of modern automatic furnace control, especially its position with respect to the several types of furnaces.

Automatic furnace temperature, roof temperature, furnace pressure, and fuel-air ratio control have taken a very important place in the operation of furnaces. They have reduced fuel consumption, maintenance, labor, loss of product, and have increased production per dollar of invested capital.

The recuperative furnace has a closed cycle of operation which maintains a smooth preheated air temperature curve, simplifying flame and furnace temperature control. In fact the entire structure is carried at a more constant temperature. The value of this condition has been overlocked by many experienced operators.

In contrast with this nearly ideal condition, the regenerative furnace has two alternating heat exchange units which, even with short reversal periods, will set up a temperature swing that causes recurrent movements and expansion creep in the heavy brick parts, opening cracks in the walls and finally resulting in so much air infiltration that precise control is impossible and the furnaces loses efficiency. In the recuperative furnace only changes in load affect the normal functioning of the apparatus, but in the regenerative system this is an added variable. Leakage in the recuperator is prevented when the design is based upon reliable fuel rates which fix sizes and therefore the gas and air pressures, and temperature differentials.

The elimination of complicated valve reversing mechanism and the control pyrometry, required in the regen erative system, also gives the recuperative furnace a higher rating for selection from the standpoint of control.

This statement may also be made in the light of a recent installation by us of a side door center outlet recuperative heating furnace, fired from both ends simultaneously, equipped with automatic temperature, pressure, and fuel-air ratio control. Compared with the regenerative furnace replaced, there is no washing, and a substantial improvement in heating and increased tonnage accompanied by a definite fuel saving. This feature has been advocated in an improved design of continuous slab heating furnace, and now, with some modification in the open hearth design just discussed.

We can state with reasonable accuracy, in the light of the various designs submitted, that a recuperative system having these features can now be built to meet all of the practical demands of many furnaces, coupled with dependability, formerly lacking in such systems. Such furnaces would have definite advantages over the less efficient, more cumbersome, but also reliable, regenerative furnace. It is merely necessary to apply this knowledge, which is now so obvious, to our other furnaces.

Our experience, which has embraced the construction of more regenerative than recuperative furnaces, leads to the unprejudiced conclusion that certain work, due to factors which are beyond our present control, may be served best by regeneration. Positive proof of better results with other furnaces, leads to the conclusion that a recuperator, in the right place, is best. Years of experimentation have produced an extraordinarily simple recuperator, which may now be selected with the assurance that it will give long and efficient service, especially in the "hands" of dependable automatic temperature and furnace pressure control—particularly the latter, which prevents the former abuse from sudden temperature shock when the furnace is open.

There are some open hearth furnaces using recuperation at present, but it can be said that if recuperation is to succeed regeneration for the open hearth, and it may, great care must be exercised in the selection, design, and arrangement of recuperators; otherwise, the result may be very unfavorable and the recuperator cast aside as unsuitable for the purpose. Any application made by experienced engineers should be equally, if not more efficient than regeneration, or the design is fundamentally unsound. We must admit that continuous unidirectional firing is desirable on all furnaces and the possibilities of using regeneration with such a system deserves some consideration. A paper on this subject would provide food for new thought.

DISCUSSION

PRESENTED BY

M. J. CONWAY, Fuel Engineer, Lukens Steel Company, Coatesville, Pennsylvania.

M. J. BRADLEY, Market Extension Engineer, Leeds and Northrup Company, Philadelphia, Pennsylvania.

E. W. WAGENSEIL, General Sales Manager, Hagan Corporation, Pittsburgh, Pennsylvania.

C. H. THOMPSON, Sales Engineer, Brown Instrument Company, Philadelphia, Pennsylvania.

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

W. A. MORTON, President, Amsler-Morton Company, Pittsburgh, Pennsylvania.

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

LINN BRADLEY, Research Corporation, New York, New York.

M. J. CONWAY: It is not my intention to dwell on the relative merits of regenerators or recuperators as applied to a particular process, except to state that in my opinion in both heating and melting operations there will be both methods of heat exchange with a decided shift to recuperators where conditions permit, with the consequent result that we shall have better furnaces of both types.

What I wish to discuss particularly, is the difference in ease of control of the recuperative furnace compared with the regenerative furnace.

The regenerative furnace is usually of the reversing type with valves that have a tendency to leak in varying degree, a supply of preheated air that of necessity changes in temperature between reversing cycles, and a furnace design which does not lend itself to perfectly tight construction, plus the changes of port areas which occur with furnace age, especially at the higher operating temperature ranges.

Let me state at the outset that I in no way deprecate the job being done by control on regenerative furnaces. From the pioneer days in 1923, when I first attempted to control a regenerative open hearth furnace at the Steubenville Plant of the Wheeling Steel Corporation, until the present I have advocated control of regenerative furnaces, but from the irregular results obtained with control not from the standpoint of control design, but chiefly because of a shift in conditions from which the control was designed to operate, it is evident that the closer we can come to complete elimination of these variables, the easier it is to successfully and completely control the operation, control design is much more simple, and because of the elimination of the variables, the efficiency of control is not difficult to check.

There are three prime considerations in the purchase of control equipment:

1. Fuel efficiency.
2. Improvement of product quality.
3. Length of furnace and equipment campaign.

These prime considerations are weighed against the cost of the control equipment, or in other words the time required to liquidate the investment.

Methods of checking the process ultimately resolve into a comparison of B.t.u. per ton, comparison of product quality or furnace losses, and a comparison of rebuilding and replacement costs of furnace and control equipment, plus any additional maintenance or supervision that the operation has entailed.

These conclusions take time, and may be misinterpreted due to changes in plant operations or methods of accounting which have taken place meanwhile, but the efficiency of the control can be readily checked by continuous analysis of the exhaust gases, and if these analyses check with the predetermined setting, then variations from theoretically perfect operation are due to conditions outside of the control function, and may be due to weaknesses in heat exchange equipment, insufficient load per furnace hour, mill delays, or other reasons that are more or less well known.

The majority of control functions are designed to give an economical waste gas analysis to fit the particular controlled operation, this being so, it is logical to start the control from the instrument reading this analysis. This method of control, while generally thought of as "down stream control", can be readily applied to recuperative furnaces, because, first—most of the uncontrollable variables have been designed out of the furnace system, and second—we can now obtain from several reliable sources analytical control apparatus.

In this type of control we are prone to argue about the lag between the analyzing sampling device function, and the time of the control function. It is true there is bound to be a time lag, but in a well thought out system, any adverse effect of this lag can be minimized.

Modesty prevents me from making a lengthy comment on Mr. Morton's reference to my conception of an improved Open Hearth furnace design, except to state that having been intimately associated with open hearth practice for a long time and having passed through a period of "growing pains" in trying to improve on present design, I was guided by three factors—cost of construction, cost of upkeep, and cost of operation. These I designed to keep at a minimum, coupled with simplicity of structure and ease of operation.

A. J. FISHER: Mr. Morton's paper on the evolution of recuperation and its application to furnaces is most interesting, and he deserves a great deal of credit for improving the status of the recuperative furnace.

Soaking pits may be divided into two classes, regenerative and recuperative. Each has respective advantages, namely:

Recuperative:

1. The automatic control of the recuperative furnaces is simpler inasmuch as the flow of air and fuel are steady and are consigned to a single source.
2. A cheaper installation cost.

Regenerative:

1. Higher heating rates because the flow of fuel

BLAST FURNACE GAS ANALYSIS

	Per Cent
CO_2	10.7
CO	27.9
H_2	1.5
CH_4	0.2
N_2	56.8
H_2O	2.9
BTU per cu. ft., wet basis—net Saturated at 60° F. and 30″ Hg = 94.3	100.00

Figure 1

is alternated thus enabling higher temperature differentials between the steel and furnace to be maintained, provided the reversing cycle is automatic and shortened as the steel approaches rolling temperature.

2. Higher heating rates because of the storage of a large mass of heat in the checkers which enables the furnace to withstand the shock of charging without cooling off appreciably.
3. Constant operating results over a long period of time, as compared to the increased leakage of recuperative furnaces in respect to time.
4. Lower average fuel costs over a long period of time.

It is generally agreed that fuels between 100 and 135 Btu are better suited for soaking pits. The mixing of fuels should be done at a central station rather than the old method of sweetening with the higher Btu gas at the individual pits.

Blast furnace gas is an ideal fuel because of its low flame temperature and low sulphur content.

Figure 1 shows a typical blast furnace gas fuel analysis.

Figure 2 shows the relation between scale, SO_2 content in the gases, and temperature. Blast furnace gas is practically sulphur free.

Figure 3 shows the relation between SO_2 and scale at 2300° F.

Figure 4 shows the flame temperature of Blast Furnace gas with preheated air.

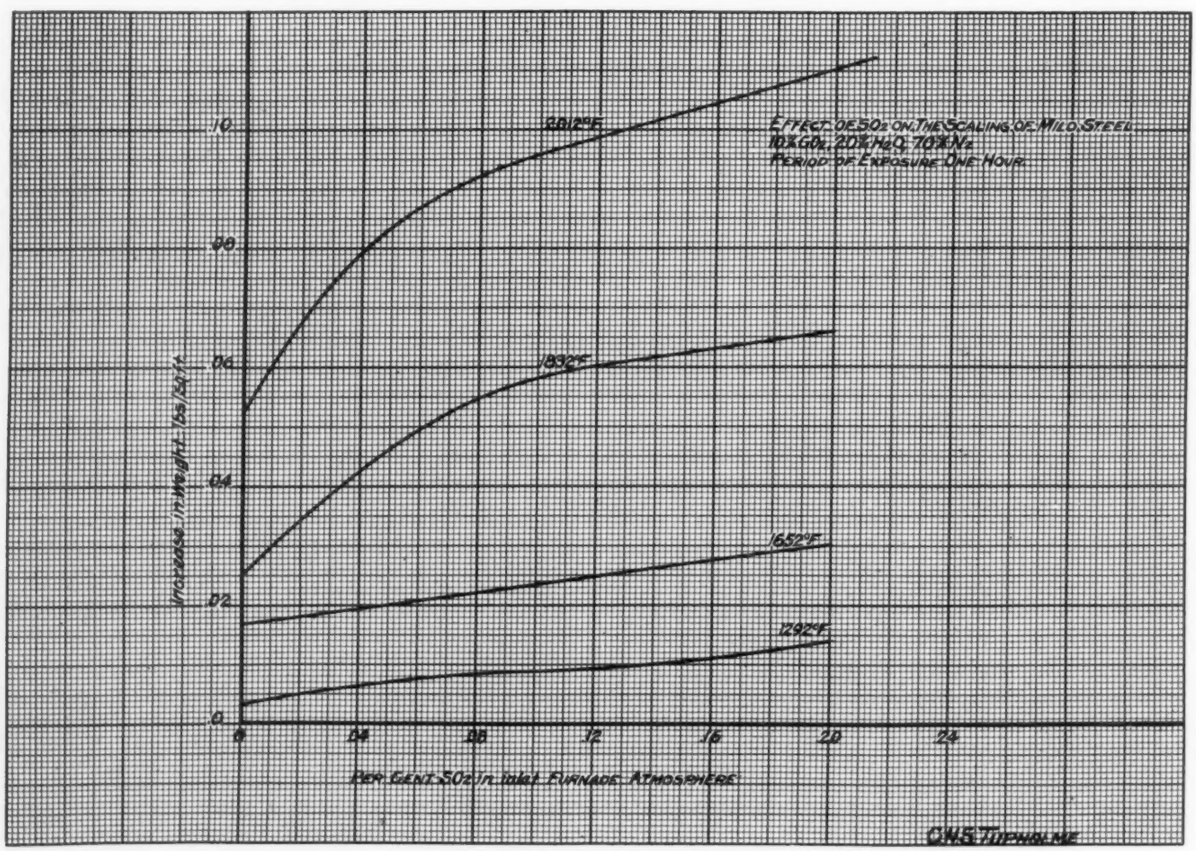
Figure 5 shows the flame temperature of mixed blast furnace and coke oven gas using cold air.

Figure 6 shows a control panel and the automatic reversing valves for a regenerative soaking pit.

Figure 7 shows the gas lines to one side of a regenerative pit. This particular pit is of the two pass checker arrangement; one pass vertical and one pass horizontal. The gas enters about two feet above the vertical checker.

Figure 8 shows the lines and valves of one mixing station.

Figure 2



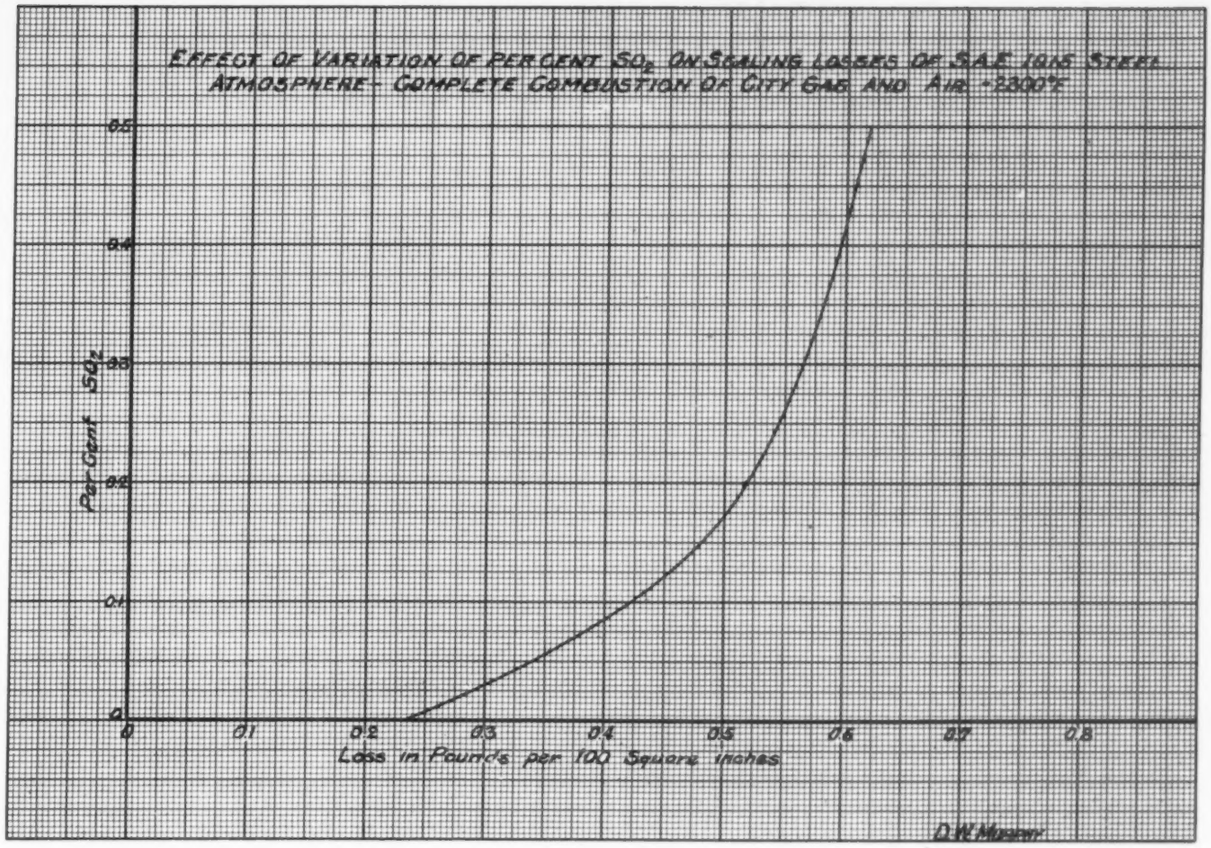


Figure 3

Figure 4

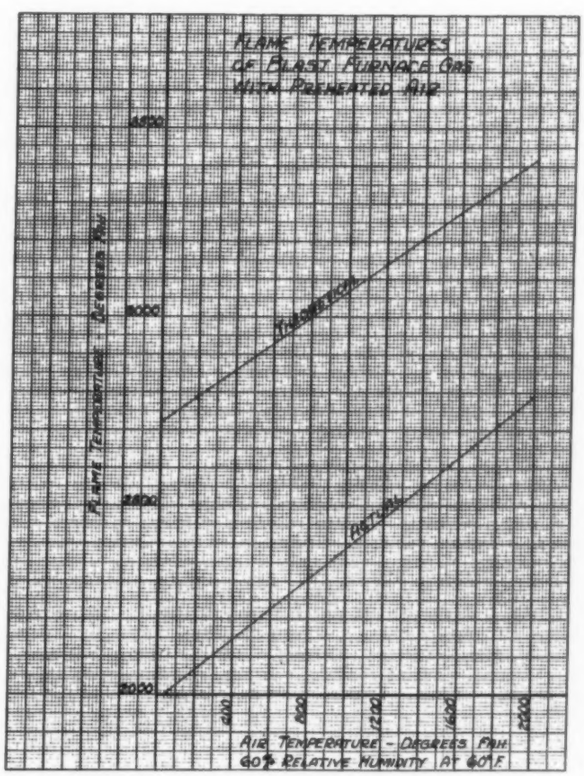
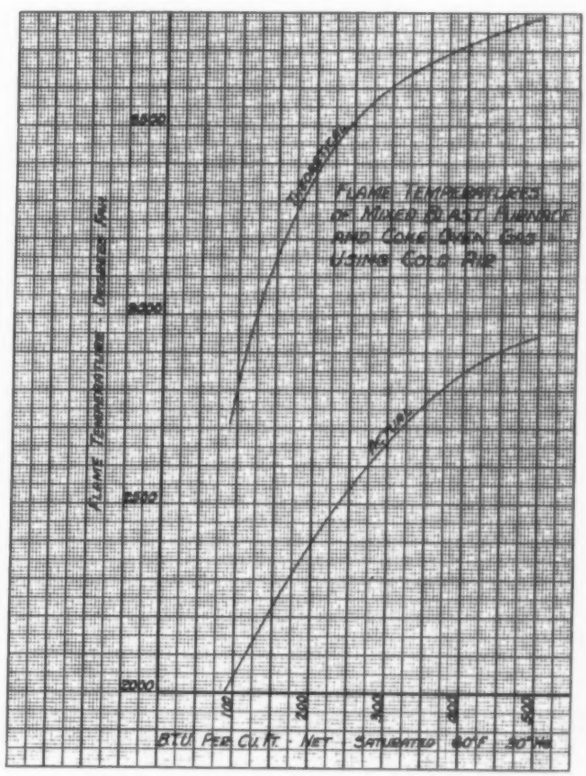


Figure 5



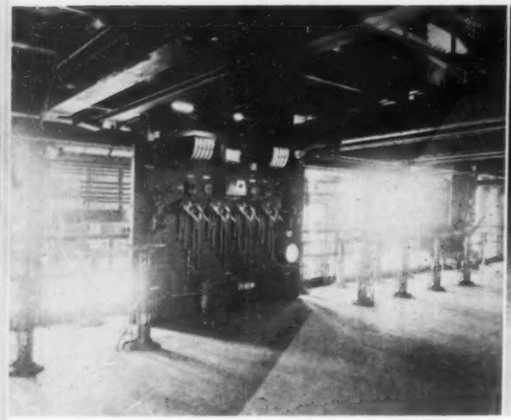


Figure 6—Control panel and automatic reversing valves for a regenerative soaking pit.

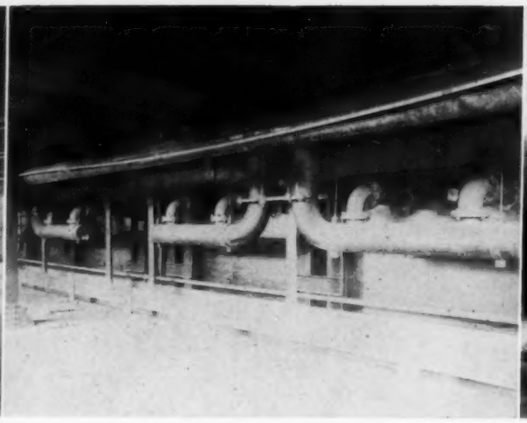


Figure 7—Gas lines to one side of a regenerative pit of the two pass checker arrangement type.

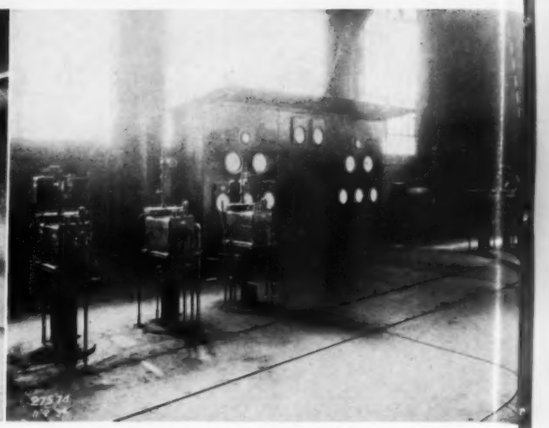


Figure 8—Lines and valves of a mixing station.

The average fuel rate for the 14 rows of old conventional regenerative soaking pits revamped for 100 to 135 Btu gas firing is 1,150,000 Btu per gross ton of ingots.

The average fuel rate for the six rows of newly designed two pass regenerative soaking pits on 95 to 100 Btu blast furnace gas is 1,222,000 Btu per gross ton of ingots.

A larger percentage of cold steel is heated in the latter pits.

The average soaking pit time on cold steel ingots is 11 hours for all pits.

The average soaking pit time on all red and black hot ingots held 2¼ hours from time of pouring until the first pit is charged is 5¾ hours.

M. J. BRADLEY: I have been assigned to talk from the "clean up position" on tonight's program. Realizing the ability of the previous speakers and the great amount of detailed information they have personally on the subject, I wish to confine my remarks to temperature measurements on an open hearth furnace. However, the same remarks may apply, in a general way, to most types of furnaces where fuel is used to obtain definite temperatures.

I might mention, as a matter of interest only, that when several men who talk a great deal about temperature were asked to define the word temperature, each had his own personal concept of the term but there was at best only a general agreement in their several statements. Fortunately for Combustion Engineers, it is seldom desirable or necessary to refer temperatures to the absolute scale. The Fahrenheit scale is used generally when dealing with industrial problems. Temperature is a measureless quantity which necessitates some means of comparison with measureable quantities and for the purpose of these remarks may be considered as the thermal state of a body with reference to its power of communicating heat to other bodies.

The temperatures usually measured on industrial applications are more often relative than actual. This fact emphasizes the importance of analyzing the temperature problem to make certain that the desired temperature is capable of measurement and if relative that definite relations will continue under like conditions. It is possible in many cases to measure different temperature conditions in the same location. To illustrate, I should like to discuss briefly some temperature curves shown on Figure 1 which were obtained in a study on an open hearth furnace system.

The furnace is shown just after reversing and fired on the right end. The curves on the right show the temperatures decreasing while the curves on the left show the temperatures increasing. The corresponding temperatures were recorded simultaneously while the firing rate and other furnace conditions were maintained as nearly constant as possible. All temperature records were made during the working of the heats and in the positions indicated on the outline diagram.

The temperatures recorded for position 1 were taken in the center of the flue close to the checker chamber. The heavy line curve 1-A shows the temperature measured by a No. 8 gage chromel-alumel thermocouple installed in a chrome iron protection tube. The curve on the left indicates that at the time of reversing this thermocouple was cooled down below 800° F. It heated up at a fairly constant rate for approximately 12 minutes and then flattened off slightly under 1250° F. It apparently would not have increased very much in temperature even had the furnace been held several minutes longer on the same end. The cooling curve on the right shows similar characteristics but in the opposite direction. These curves show relative temperatures resulting from waste gas and air temperatures, radiant heat from the brick work in the checkers and flues, heat conduction of the thermocouples and protection tubes, etc. In fact, they show only the rate at which these particular lagged thermocouples heat up and cool down in this location under the particular working conditions.

The temperatures shown on curve 1-B were taken as nearly as possible in the same positions in the middle of the flues as those under 1-A. The thermocouples used were No. 8 gage chromel-alumel without any protection tube covering the hot junctions. It may be noticed that these thermocouples heated up and cooled down at a much faster rate immediately after reversing than the lagged thermocouples. Also that they heated up approximately 200° F. higher but cooled down less than 100° F. lower than the lagged thermocouples. The small difference in the cooling down is probably

due to the radiant heat effect from the brickwork in this location. These curves show relative temperature records for the particular set of conditions.

A third set of temperature measurements was made in the same locations and shown on Curves 1-C. The readings were made by means of low velocity aspirating couples using No. 22 gage chromel-alumel thermocouples, on a heat when the checker systems were considerably unbalanced. It may be noted that the heating up curve increased rapidly immediately on reversing from below 400° F. to 1700° F. in approximately one minute and then slowly increased to 1800° F. at the end of 15 minutes. The cooling down curve dropped rapidly from slightly above 1500° F. to approximately 500° F. in the same interval and then slowly decreased to below 400° F. at the end of the reversing period. The low points on the two curves show very close agreement reflecting the air temperature entering the checker chambers. The maximum temperatures shown for the waste gas differ by approximately 300° F. This may be accounted for by the combustion conditions within the furnace and the unbalanced thermal conditions in the checker systems.

These temperature measurements were made to obtain temperature readings on the air entering and the waste gases leaving the checker systems. While the readings obviously approach much nearer to the actual temperatures desired, they, however, represent relative temperature measurement only under the conditions and methods employed. The true temperatures would undoubtedly show a higher maximum and possibly a lower minimum than indicated. In spite of the fact that true temperatures of the air and waste gases are more desirable, the majority of the practical installations use the lagged thermocouple in these locations, due principally to maintenance considerations.

A similar set of temperature measurements were made in the locations marked 2. The curve 2-A shows the results obtained with a bare 14 gage chromel-alumel thermocouple resting on the top checker brick surface. The curve 2-B shows the record obtained with a radiation pyrometer sighted on the same surface. The two sets of temperature curves indicate similar characteristics. The bare couple deteriorated rapidly and was destroyed before the end of the heat.

It was almost impossible to make satisfactory low velocity aspirating thermocouple readings simultaneously in these locations. However, several separate records were obtained on different heats. Comparing the results with the radiation temperature records of the checker brick surface in the same location, it was evident that the temperature of the gases and the brick surface paralleled each other except immediately after reversing when the gases changed in temperature at a much faster rate. In general it was found on the heating curves the waste gas temperatures recorded on the aspirating thermocouple were from 80° F. to 130° F. higher than the radiation pyrometer readings on the brick surface. On the cooling down curve the brick surface temperature was approximately the same amount higher in temperature than the combustion air.

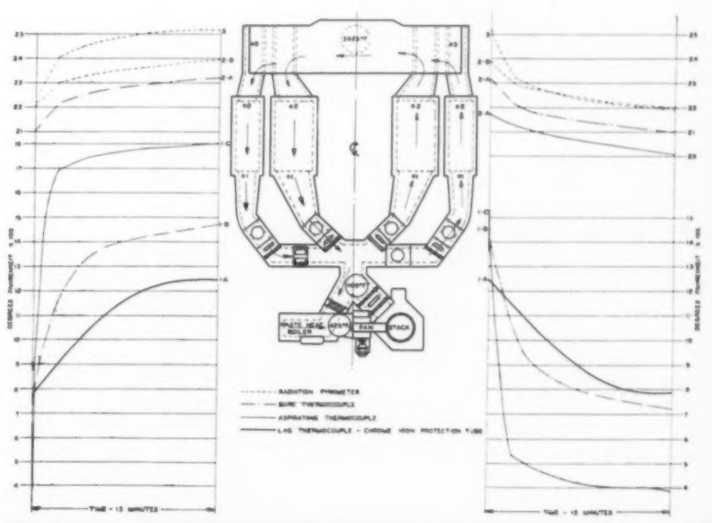
The heating and cooling curves shown for position 3 (in the uptakes above the charging floor level) were made with radiation pyrometers. It may be noticed that these curves show a rapid rate of change immediately after reversing. Approximately two-thirds of the total temperature change noted takes place during the first minute after reversing. This is probably due to the rapid temperature change of the thin surface of the brick before the actual conduction of the heat to or from the deeper layers of the brick has had time to compensate for surface heat change.

The cooling curve 3-A was obtained with a low velocity aspirating couple, using an ordinary platinum-platinum rhodium thermocouple. This record was not made on the same heat as the radiation records, therefore does not bear any definite relation to them. It is included to illustrate the cooling down of the combustion air during the interval between reversals. For instance, immediately in reversing the air for combustion passing this location was heated to around 2180° F. while the air passing just before the next reversal was around 2000° F. The maximum temperature of preheat is very little higher than that mentioned by Mr. Morton—2150° F. leaving the superheater. The falling off of temperature during the cycle is peculiar to the regenerative process. It was impossible to obtain a heating up curve of the waste gases by this method due to the fact that the products of combustion destroyed the platinum thermocouple immediately on reversing.

The temperature 3025° F. shown on furnace diagram is an average maximum temperature measured by a radiation pyrometer sighted through the back wall on the inside surface of the roof. The temperatures 1100° F. shown before, and 425° F. shown after the waste heat boiler were taken with lagged chromel-alumel thermocouples.

These temperature curves illustrate the importance of careful analysis of the temperature measurement problem and demonstrate how different temperature records may be obtained in the same position under identical conditions. If it is possible and practical to

Figure 1—Temperature curves of an open hearth furnace just after reversing and fired on the right end.



measure the temperature that is to be controlled, the control problem is greatly simplified.

E. W. WAGENSEIL: We have read with keen interest Mr. Morton's paper, and wish to compliment him on the interesting manner in which he has portrayed a highly technical subject.

We must all agree that the value of bringing new ideas, from hitherto more or less outside sources, into the field of steel mill furnaces has been clearly demonstrated in the field of soaking pits. Not only was the Amsler-Morton pit, which was installed at the Mingo Works of Carnegie-Illinois Steel Corporation in the spring of 1936, the first of this new type, but so far as we know, it was the first soaking pit to be equipped with complete automatic control including control of fuel input from temperature and automatic gas shutoff when the cover of the pit is lifted. That this pit worked with complete success right from the start was a fine tribute to its designers and to the manufacturers of the various elements of control equipment involved. In Mr. Morton's paper, he mentions that the recuperators on this pit have "successfully withstood a series of floods." Specifically, you might be interested to know that this pit was brought up to temperature for the first time the day before the St. Patrick's Day flood in 1936. When it was found that the water was rising rapidly, the pit was cooled to approximately 1000° F. before the water entered the recuperators. The peak of the flood carried the water to 1″ higher than the top of the pit. When the water subsided, the pit was dried out and placed in service shortly thereafter, with no apparent damage. The recuperators on this pit have been submerged by three subsequent floods, also with apparently no damage. This seems to us quite remarkable and certainly is a strong endorsement of the design and the material used in the recuperator construction.

The advantages of complete automatic control on soaking pits, as demonstrated by this first pit, and by subsequent installations on a large number of new pits of this type and other types in important steel mills during the past year, have been outstanding. Control equipment is now available with sufficient sensitivity, speed, stability, and reliability to meet the requirements of practically any control problem that has developed thus far in the steel industry. Close cooperation and a mutual understanding between the control manufacturers and the designers of furnaces and soaking pits has made this possible.

C. H. THOMPSON: I was especially interested in the advantages of regenerators cited by Mr. Fisher to the effect that they had additional heat capacity to withstand temperature shock. Comparing that with Mr. Morton's chart it would seem to me very interesting that the inlet air temperature didn't vary more than fifty degrees in spite of the fact that a cold charge was put into the soaking pit. I was quite surprised that this could be possible with a recuperator. I wonder if Mr. Morton can tell me why the air did not drop more than fifty degrees in spite of the sudden changes in the pit temperature.

In Mr. Bradley's paper I was interested in those temperatures on the right-hand side of the chart that showed the inlet to the regenerator. On the outlet side the line went steadily and did not cross but on the inlet side, as the thermo-couple tube was removed the lines crossed each other and showed that they dropped rapidly, and I wonder if that was the effect of the cold air going in and striking the couple.

L. F. COFFIN: Referring to the chart presented by Mr. Morton showing relatively low drop in incoming air temperature when cold steel was charged into the recuperative type soaking pit, I would like to know whether this represented the withdrawal of the entire hot charge from the pit and the placing of the entire new cold charge and if not, what proportion of the number of ingots in the pit was changed.

W. A. MORTON: Referring to your question Mr. Coffin, the chart showing the temperature readings was obtained by consecutive hourly recordings of the air temperature for 24 hours during which time 4 heats were drawn.

After the 3rd heat was drawn the pit temperature fell 325° while the preheated air temperature dropped 50°. The lowest air temperature prevailed one hour and 45 minutes after charging the third heat.

In each case 16 ingots comprised the charges and all were drawn and replaced with a new charge.

The means for sustaining the high air preheat throughout these wide furnace temperature variations is simple.

In a batch type furnace the charge extracts the heat from the pit walls; prescribed heating rates then demand high fuel rates; air flow is correspondingly fixed and as it cannot be sustained in its previous plans by the greatly lowered waste gas temperature (325° lower), the heat necessary for maintaining the air temperature must come from the structure surrounding the recuperator—not the heat exchange elements themselves. This result obtains only in the Amco form of recuperation where waste gases pass through the tubes and air passes in contact with the saturated walls of the heat exchanger.

Obviously, the wall surface must be and is extended beyond normal or general practice, by cellular construction. This adds to investment but it gives speed to the furnace and lessens the demand on the automatic control system.

M. J. BRADLEY: Mr. Thompson asked why the cooling down curves cross. The chart shows three different temperature cooling curves taken in the same location—Position 1. Curve 1-A shows the temperature cooling rate recorded on a heavily lagged thermocouple. Curve 1-B shows the cooling rate recorded on a bare thermocouple without the lagging effect due to the protection tube. Curve 1-C shows the cooling rate recorded from the aspirating thermocouple. The two latter cool at a much faster rate than the former so that these curves cross the former. The difference in the curves is due entirely to the difference in cooling rates of the three thermocouple systems (or the mass which must respond to the temperature change) and the average of the temperature conditions to which they are responding. The average temperature to which each couple is responding is different in each case. It is evident that the temperature recorded on the aspir-

(*Please turn to page 45*)

The **NEW JONES & LAUGHLIN STEEL CORPORATION'S 96" CONTINUOUS HOT AND COLD STRIP MILL** ★ ★ ★

JONES & LAUGHLIN'S NEW 96" CONTINUOUS HOT & COLD STRIP MILL

▲ PROMPTED by the desire to put their flat-rolling facilities in line with the expanded markets for these products, the Jones & Laughlin Steel Corporation, in 1936, began construction of a 96" continuous strip mill in their Pittsburgh Works. This mill is located on a site of more than 23 acres between the Monongahela River and Second Avenue, Pittsburgh, abutting the Eliza Furnace plant, and, together with its auxiliary departments, is housed in a compact layout of buildings totaling 982,000 sq. ft. of floor space and extending approximately 2280 ft. in length and 465 ft. in width. The principal components of this group will be found on table 1, on the following page.

The magnitude of the project is well illustrated by the quantities of material entering into the construction of these buildings. Foundations for buildings and equipment required 96,200 cu. yds. of concrete, and due to soil conditions, 88400 lineal feet of pipe piling filled with concrete were used for foundation support. Structural steel to the extent of 18500 tons is covered with 1370000 sq. ft. of corrugated sheeting and 223000 sq. ft. of steel sash to form the buildings. About 4½ miles of sewer piping, 30 miles of service piping and 135 miles of conduit were used in the construction.

The hot mill has a nominal capacity of 75000 gross tons per month, and is designed to roll a minimum thickness of No. 19 gauge x 42" wide, or No. 10 gauge x 91½" wide, with a maximum thickness for sheared plate of ½" in widths up to 90". Production averages about .107" in thickness x 60" in width.

The general plan of the mill accompanying this article shows the compact grouping of the various departments along natural lines of material flow through the plant.

H. E. LEWIS, *Chairman of the Board*

SLAB SUPPLY

Slabs for the strip mill are furnished largely from the new 44" 2-high reversing blooming mill installed in the South Side steel plant directly across the Monongahela River. This mill was placed in operation early in 1936, and carries a unique feature in the use of the first all-welded manipulator ever built. Almost 2000 separate pieces go to make up this manipulator, the fabrication of which required 16000 lineal feet of electric welding. It is hydraulically operated in connection with a pneumatic accumulator. This type of accumulator acts as a cushion as well as a control device for the accumulator pumps, which are centrifugal pumps of 1000 G.P.M. capacity at 600 lb. per sq. in.

The mill is driven by a 7000 H.P., 50-120 R.P.M. 750 volt D.C. motor. Power is supplied to this motor from a dual motor-generator set consisting of two 3000 K.W., 750 volt D.C. generators and one 5000 H.P., 6600 volt, 375 R.P.M. wound rotor induction motor, with a flywheel rated at about 175000 H.P.-seconds. This set is controlled through a liquid slip regulator.

The blooming mill sub-station is air-conditioned, clean air coming into the room through ducts and forcing the old air out through louvres near the top of the room.

The blooming mill is served with ingots of 8500–25000 lb. weight from five blocks of soaking pits, each of seven holes 8'–6" long x 6'–1½" wide. Ingots are

Keeping pace always with the requirements of the nation's steel-using industries, Jones & Laughlin now has in production, in all departments, the 96-in. continuous strip mill for which ground was broken on April 27, 1936. The mill occupies 23 acres of land on the north side of the Monongahela River, and is the newest unit of the Jones & Laughlin Pittsburgh Works.

With its completion, Jones & Laughlin extends its manufacturing facilities to supply all major products in the range of carbon steel commodities. To the right is seen the finishing stands of this new mill.

drawn from the pits by pit crane, of which there are three, of 15 tons capacity, placed in a buggy and taken to an overhead transfer, which in turn carries the ingot to the mill table. Provisions are made for weighing the ingot if desired.

Blooming mill rolls have a maximum diameter of 42″, with a body length of 90″, and are hydraulically balanced, with a maximum lift of 46½″. Slabs up to 48″ in width can be rolled.

An underground scale flushing system extending underneath the blooming mill tables is an unusual feature of this mill.

Lubrication of this mill is provided by an automatic greasing system on the manipulator and transfer, a grease system for the mill feed roller bearings, the roll necks and the shears, and an automatic flood oiling system which covers table roll bearings, drive bearings, gears, etc.

The blooming mill shear is hydraulically operated, and is rated at 2000 tons. An opening 18″ high is provided, with a 20″ stroke. Shear blades are 52″ long. Shear croppage drops down upon a gate which can be operated so as to divert scrap through chutes into either of two scrap buckets, making segregation of scrap types a simple matter. While scrap buckets are being pulled, a considerable amount of scrap may be accumulated in the chutes.

Slabs proceed from the shear to either of two slab pilers located farther along the mill run-out table, from whence they may be handled by overhead crane in the stockyard. Railroad cars of special design have been provided so that hot slabs may be loaded and shifted across the river to the strip mill.

SLAB YARD

Slabs coming to the strip mill range 22½″–48″ in width, 4″–6″ in thickness, 60″–188″ in length, and 3000–9760 lb. in weight, and average about 48″ x 5″ x 87″ in size and 5000 lb. in weight.

The slab yard is 100 ft. wide x 650 ft. long, and contains chipping beds whereon slab surfaces may be conditioned for rolling. A scale is also provided so that actual slab weights may be obtained. Two 25 ton overhead cranes, with 15 ton auxiliary hoists, unload cars, stock slabs, and supply the magazine feeder which, together with the furnace charging table and pushers, extend back into the slab yard. A 25 H.P.

S. E. HACKETT, *President*

Slabs for the strip mill are furnished largely from this 44" two-high reversing blooming mill installed in the South Side steel plant, directly across the river. This mill is driven by a 7,000 horsepower motor.

D.C. motor drives the magazine feeder, which supplies one slab at a time to the furnace charging table. This table is 112 ft. long, extending across the back ends of

S. S. MARSHALL, JR., *Vice President*

TABLE 1	Length, ft.	Width, ft.
Slab yard	650	100
Slab furnace building	150	65
Motor room	490	65
Hot mill building	725	90
Roll shop	125	60
Blue annealing building	1078	115
Coil storage building	628	70
Continuous pickling building	628	70
Hot mill finishing building	781	115
Plate finishing and shipping	781	95
Cold rolling building	906	115
Cold mill finishing	553	90
Cold mill shipping	728	100
Batch annealing building	728	148
Galvanizing building	353	150 & 125

the furnaces, and is composed of three sections, each driven by a 50 H.P., D.C. motor. Each furnace is supplied with a double arm pusher, driven by two 50 H.P., D.C. motors. Separate operation of the two arms permits double row charging of slabs up to 7′–6″ in length into the furnace, which is usual practice, while the two arms may be mechanically locked together for single row charging of longer slabs.

FURNACES

Three continuous heating furnaces are installed, of triple-fired design, zone-controlled, end charged and end discharged, with hearth dimensions of 79′ x 18′, and an overall length of 87′–1½″. The primary heating zone is 61′–9″ long, and is equipped with water-cooled skids on refractory piers. Six burners firing above the steel and six below the steel form the combustion equipment of the main heating zone, while eight more burners overfire the soaking zone, which is about 18 ft. long, with a solid hearth composed of refractories covered with about 6″ of chrome ore. The furnaces have flat suspended arch roofs, and are completely insulated and steel encased.

Each furnace is equipped with a refractory tile recuperator which heats combustion air to a temperature averaging about 600 degrees F., with a maximum of 800 degrees F. Air is pulled through the recuperators by high temperature fans designed for a maximum temperature of 1300 degrees F., with a capacity of 45000 c.f.m. at 800 degrees F., 2½″ static pressure, and driven by 50 H.P. induction motors. Stack temperatures are normally 1000-1100 degrees F.

Each furnace has a nominal rating of 50 gross tons per hour of cold slabs 6″ in thickness. Furnaces are fired with coke gas and tar, in proportions ranging 100% coke gas to 20% coke gas and 80% tar. The soaking zones use only coke gas, while the heating zones may use either coke gas or tar. The general scheme of operation calls for a constant firing rate in the soaking zone, with a variable rate of firing in the main heating zone depending on the rate of operation. Fuel-air ratio controls are applied to the soaking zones. Furnace pressure is automatically controlled, as is furnace tem-

perature. A complete layout of meters and gauges, which are grouped on a control panel board for each furnace, aid materially in the proper and efficient operation of these furnaces.

HOT MILL

At temperatures of 2150-2250 degrees F., slabs are discharged from the furnace through tight-closing delivery doors on to the mill approach table, which is about 118 ft. long, sectionalized into three units, each driven by a 50 H.P., D.C. motor. The first unit of the hot mill is a 2-high, 24″ x 76″ scale breaker, driven by a 1000 H.P., 6600 volt, 375 R.P.M. squirrel cage motor. Furnace scale, which is cracked loose by the slight reduction in this pass, is removed from the slab by hydraulic sprays operating at a pressure of 1150 lb. per sq. in. Following the scale breaker at a distance of 31′–4″ is a 4-high, 38″ and 51″ x 96″ stand, driven by a 3000 H.P., 6600 volt, 150 R.P.M. induction motor with a built-in flywheel of 20 ft. diameter, 45000 H.P.-sec. This stand is a broadside mill, in which slabs up to 90″ in length may be rolled either end-ways or broadside, the latter operation serving to increase slab width beyond the original width. To make rolling in this position possible, a turntable is located in the mill table preceding this stand, with a second turntable immediately following the mill to restore the slab to its original axis for subsequent rolling. Both turntables operate from a hydraulic lift, with 7½ H.P., D.C. motors driving the turning motions. To insure proper entry of the slab into the broadside mill, a slab pusher, driven by a 150 H.P., D.C. motor, is provided. A slab squeezer, driven by a 265 H.P., D.C. motor, follows next, in which the slab is trued and squared to the desired width, and flattened.

Next, 44′–5″ beyond the broadside mill, is a 4-high, 28″ and 51″ x 96″ roughing mill, followed by two more 4-high roughing stands, 27″ and 53″ x 96″, spaced respectively 52′–6″ and 82′–6″ from the preceeding stand. The spacings of the roughing stands are such that the slab is in only one stand at a time. Each stand is driven by a 3000 H.P., 6600 volt induction motor containing two flywheels of 11′–6″ diameter, 55000 H.P.-sec. The last three roughers are equipped with vertical edging rolls 11″ long x 22″ diameter, integral with the mill stands, each driven by a 150/187½ H.P., 230 volt, 450/900 R.P.M., D.C. motor which is mounted on top of the mill housing. These motors are geared to give an edger roll speed of 38.8-77.6 R.P.M.

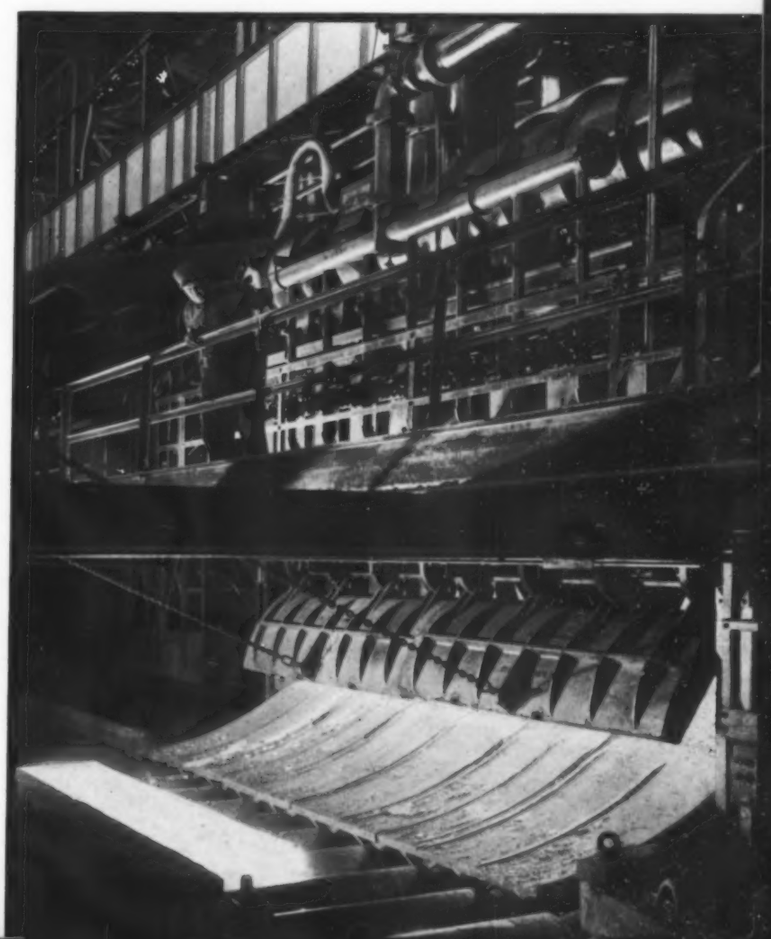
Leaving the roughing train, the steel passes over a roller table 110′–11″ long, which leads to the finishing train, the first unit of which is a 2-high, 25½″ x 94″ scale breaker driven by a 500 H.P., 600 volt, 150/600 R.P.M., D.C. motor. Following this are six finishing stands, 4-high, 27″ and 53″ x 96″. Spacings of these stands are 14′–8″ between the scale breaker and the first finishing stand, and 18′ between each of the finishing stands. The first five finishers are each driven by a 4500 H.P., 600 volt, 125/250 R.P.M., D.C. motor, and the last one by a 3000 H.P., 175/350 R.P.M. motor of the same characteristics.

Five loopers are installed, one between each of the finishing stands, serving to take up any slack in the strip as it passes through the finishing train. Each looper is driven by a 50 H.P., D.C. motor with manual control. Guides located between the finishing stands insure proper entry and delivery at each stand.

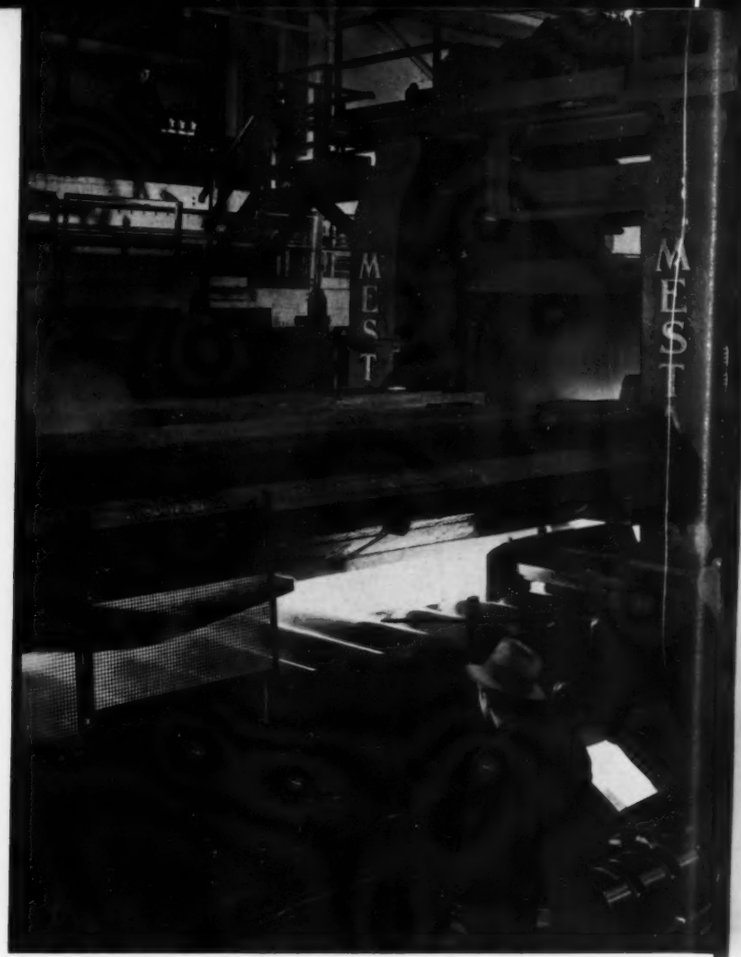
Screwdowns on each scale breaker are driven by a 15 H.P., D.C. motor, while those on the other mill

J. C. FOSTER, *General Manager of Sales*

Delivery end of one of the three continuous slab heating furnaces. Each furnace has a nominal rating of 50 gross tons per hour of cold slabs, 6 inches in thickness.

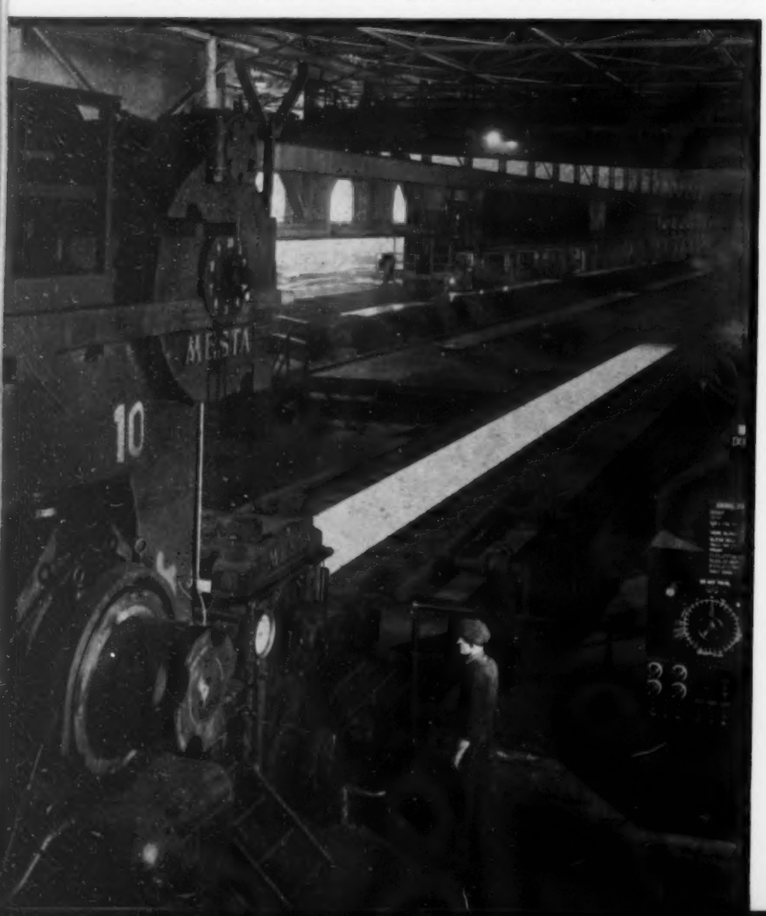


H. D. STARK, *General Superintendent, Pittsburgh Works*

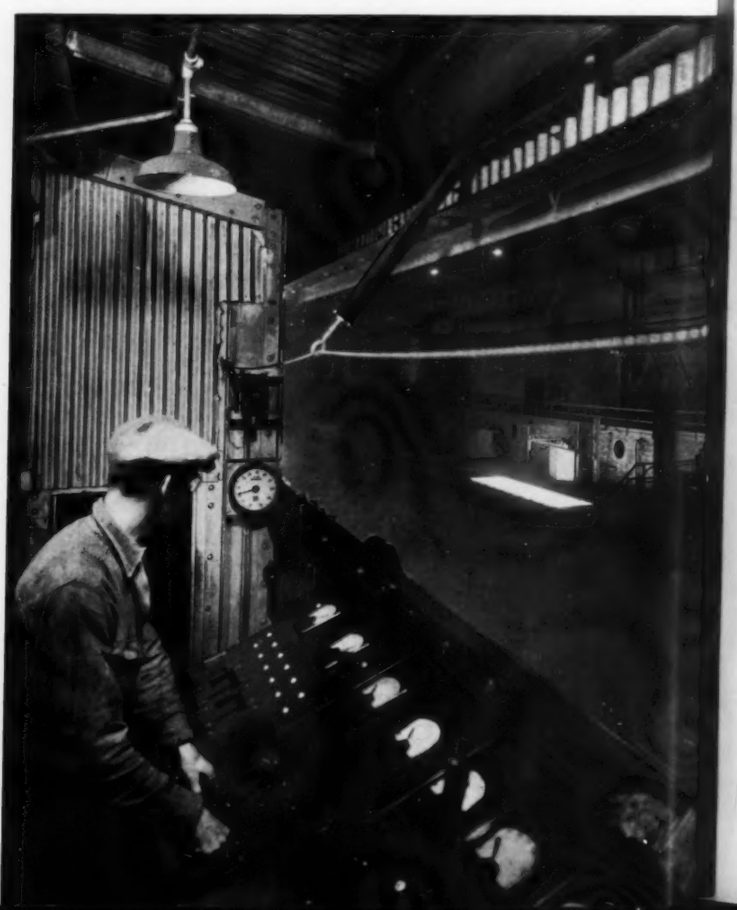


The No. 1 stand of the hot mill roughing train, where the slab is reduced in thickness and ultimate width of the finished product is established.

At a speed of 1400 ft./min., this illustration shows hot steel for plates leaving the final stand of the finishing train. Strip may be delivered from this stand at speeds of about 2000 feet per minute.



The speed operator watches the reading of the indicating dial, and does not permit the steel to go into the finishing train, until it has reached the desired rolling temperature.



stands are driven by two 75 H.P., D.C. motors. Thus, either side of the mill may be adjusted separately from push buttons located on the mill housings, or both screws can be adjusted together, being connected through a magnetic clutch.

All bearings on the back-up rolls in the hot mill are of the oil-flooded type. Babbitted bearings are used on both scale breakers and on the work rolls of the broadside mill. All other work rolls are supplied with anti-friction bearings. Edger rolls work in bushed bearings.

Hydraulic sprays for descaling and cleaning the strip as it passes through the mill are placed at the following points:

No. 1 scale breaker, exit side, top and bottom.

No. 1 broadside, exit side, top.

No. 2 rougher, exit side, top.

No. 3 rougher, exit side, top.

No. 2 scalebreaker, exit side, top and bottom.

No. 10 finisher, exit side, top.

Strip may be delivered from the hot mill at speeds up to about 2000 ft. per min., depending on its gauge. Speeds through the various stands are as follows:

Stand.	Motor Speed R.P.M.	Roll Speed R.P.M.	Strip Speed Ft. per Min.
No. 1 scalebreaker...	375	42.57	267.9
No. 1 broadside.....	150	19.11	190.5
No. 2 rougher.....	375	48.8	351.8
No. 3 rougher.....	500	64.1	453.
No. 4 rougher.....	500	64.1	453.
No. 2 scalebreaker...	150/600	17. / 68.1	114/ 455
No. 5 finisher.....	125/250	33. / 66.	234/ 468
No. 6 "	125/250	55.3/110.6	391/ 782
No. 7 "	125/250	80.6/161.2	570/1140
No. 8 "	125/250	104.8/209.6	741/1482
No. 9 "	125/250	125. /250.	884/1768
No. 10 "	175/350	146.7/293.4	1037/2074

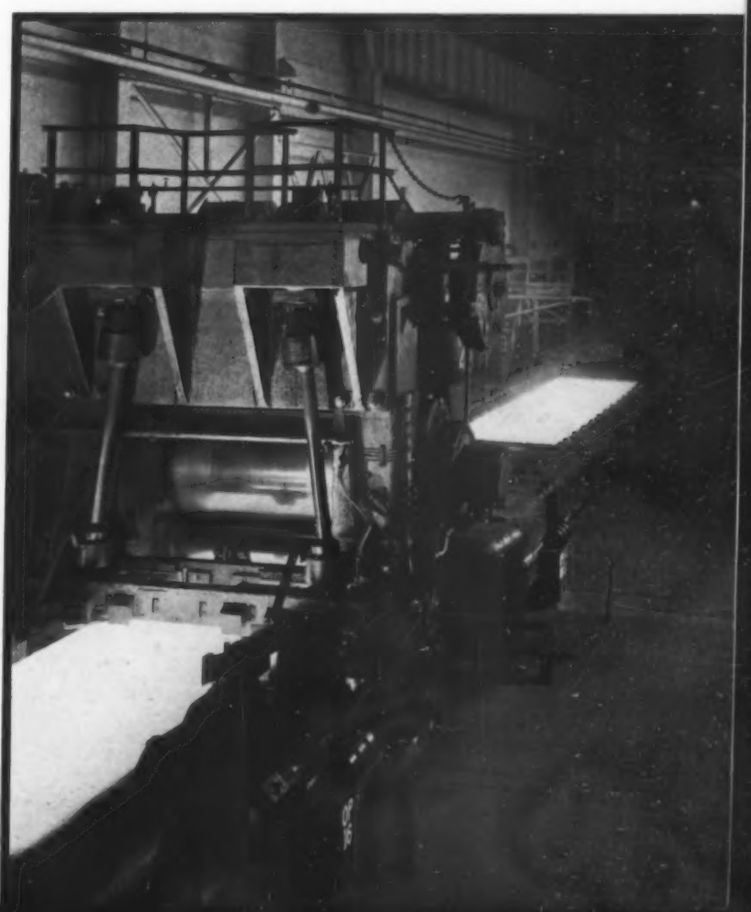
Spaced 11′–9″ from the last finishing stand is a rotary flying shear designed to cut finished strip up to 91½″ wide x 5/16″ thick into lengths ranging 11-22 ft., or it may be used to crop the front end of strip that is to be coiled. The shear is driven by twin 150 H.P., D.C. motors, controlled hydraulically from No. 10 finishing stand.

Two coilers are installed in the hot mill runout table, 370 ft. from No. 10 stand. They are each driven by five 15 H.P. variable frequency A.C. motors which are synchronized with the mill runout table and No. 10 finishing stand. Coils with a maximum width of 91½″, an inside diameter of 24″, and an outside diameter up to 44″ may be accommodated. Air operated pushers remove coils from the coiler mandrels, and a chain conveyor carries them to the coil storage building.

Runout tables in the hot mill and plate finishing department are equipped with individually driven rollers, controlled through variable frequency and volt-

J. C. MURRAY, *Asst. Gen. Supt., Pittsburgh Works*

Slab of steel entering the last of the four roughing stands, while another slab just emerged from the roughing stand is approaching the finishing train of the hot mill.



age. About 866 motors of 2.5-7.5 H.P., and .5-1.5 H.P., are used for this purpose.

About forty-seven solenoids and thrustors are used to operate spray valves, coil ejectors, hold-down valves, furnace charging doors, etc. Remote indication of screwdown positions on all hot mill stands is installed. A three station signal system connects No. 10 finishing stand, the coiler pulpit, and the end piler. Two radiation pyrometers are provided, one over the holding table between roughing and finishing trains, and one at the flying shear.

MOTOR ROOM

The hot mill motor room is 490 ft. long x 65 ft. wide, and is located between the hot mill building and the slab yard.

Twelve hot mill drives, with their reduction gears, control equipment, switchgear, etc., are located in this room. Four out of the five A.C. motors on the roughing stands are controlled by liquid slip regulators. The seven D.C. motors driving the finishing train employ Ward-Leonard control and receive their power from three dual motor-generator sets, each consisting of two 3000 K.W., 600 volt D.C. generators driven by one 6500 K.V.A., 100% P.F., 8400 H.P., 375 R.P.M., 6600 volt, 3 phase, 25 cycle synchronous motor, with 250 volt D.C. excitation.

The small variable frequency motor-generator sets used on coilers and individually driven table rollers also draw their power from these main motor-generator sets, and are located in the motor room.

Auxiliary D.C. power is derived from two motor-generator sets, each composed of a 1500 K.W., 250 volt D.C. generator driven by a 2100 K.V.A., 500 R.P.M., 6600 volt motor. A 3000 K.V.A. bank of transformers, 6600/440-220 volts, furnishes auxiliary A.C. power.

The motor room and the rotating electrical machinery contained in it is ventilated by recirculation of air. Air is cooled in eleven fin-tube type surface coolers and blown into the motor room, which is kept under a slight pressure, so that air from the room passes down through the electrical machinery and returns to the coolers.

Motor room of the new mill, which houses the twelve hot mill drives totalling 45,000 horse power. These motors drive the scale breakers, roughing, and finishing standsof the hot mill.

A multi-panel automatic air filter serves to clean the air in the system. Fan equipment in this ventilating system consists of four fans, 82500 c.f.m. capacity, each driven at 730 R.P.M., by a 75 H.P. motor, two fans 20,250 C.F.M. capacity with 20 H.P., 1450 R.P.M. motors, and two 18500 c.f.m. fans with 5 H.P., 1730 R.P.M. motors. All fans are rated at 3.8″ static pressure. This type of ventilation gives a cool motor room, as well as cooling the electrical units, at low cost.

PLATE FINISHING

Cut lengths of the lighter gauges from the flying shear are carried down the hot mill runout tables, wherein are located two piling stations, one just following the coiler location, and the other at the end of the runout table some 250 feet farther on. Additional time for cooling of plates and heavier gauge sheets is provided by the installation of three roller tables paralleling the runout table. A chain-type transfer 250 ft. wide moves heavy gauges to the first of these tables, which is about 650 ft. long, and contains a 96″ x ½″ 17-roller plate leveller and a 96″ x ½″ plate shear, where mill lengths are cut to 100 ft. maximum lengths.

A second chain-type transfer 98 ft. wide carries the plate to the second cooling table, about 625 ft. long, from where a third chain-type conveyor, also 98 ft. wide, takes the plate to the final table, which contains a rotary side-trimming and slitting shear for plate up to 90″ sheared width x ½″ thickness, a 96″ x ½″ seventeen-roller plate leveller, and a 96″ x ½″ plate shear. At both ends of this last table there are roll-off skids installed, with electrically driven roll-off arms to permit sliding the plate onto the skids.

The plate finishing department also includes a 96″ x 5/16″ trimming line made up as follows:

One electrically operated charging table designed for feeding one plate at a time, of 91½″ x 5/16″ x 22′–0″ maximum dimensions.

One rotary side trimming and slitting plate shear.

One 96″ x 5/16″ fifteen roller leveller.

One 96″ x 5/16″ motor driven up-cut shear.

One motor operated gauger table with an automatic gauge for lengths ranging 42″ to 22′–0″.

Gravity table and piler.

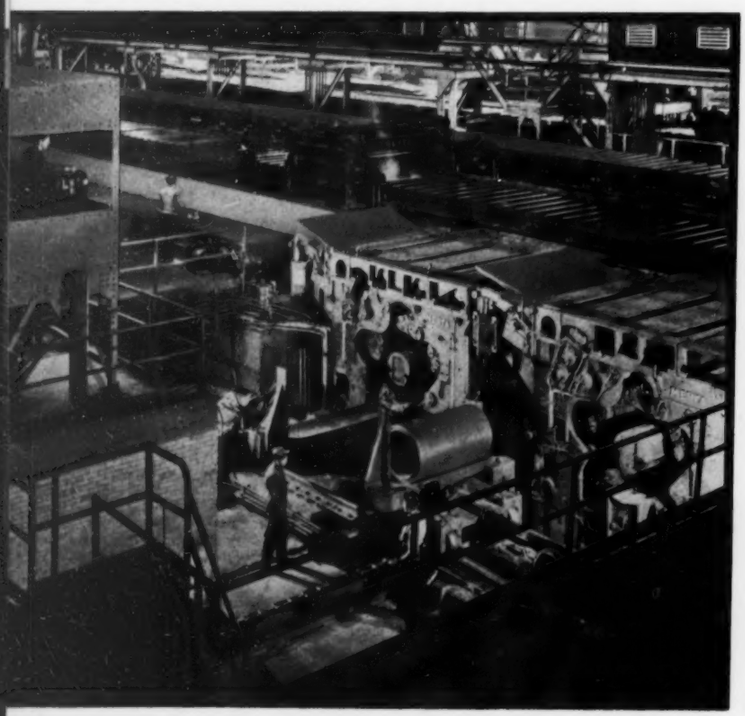
There are also a ½″ x 156″ squaring shear and a

MILL DATA

Mill	Characteristics	Work Roll Dia.	Back-up Roll Dia.	Roll Lgth.	MOTOR H.P.	MOTOR Volts	MOTOR R.P.M.	MOTOR Type	Remarks
HOT MILL									
Scale breaker	1-Stand, 2-High	24″	—		1000	6600	375	Squirrel-Cage.	Geared.
Broadside Mill	1-Stand, 4-High	38″	51″	96″	3000	6600	150	Induction	Geared. Flywheel.
Rougher	1-Stand, 4-High	28″	51″	96″	3000	6600	375	Induction	Geared. Two flywheels.
Rougher	1-Stand, 4-High	27″	53″	96″	3000	6600	500	Induction	Geared. Two flywheels.
Rougher	1-Stand, 4-High	27″	53″	96″	3000	6600	500	Induction	Geared. Two flywheels.
Scale breaker	1-Stand, 2-High	25½″	—	94″	500	600	150/600	D.C.	Geared.
Finisher	1-Stand, 4-High	27″	53″	96″	4500	600	125/250	D.C.	Geared.
Finisher	1-Stand, 4-High	27″	53″	96″	4500	600	125/250	D.C.	Geared.
Finisher	1-Stand, 4-High	27″	53″	96″	4500	600	125/250	D.C.	Geared.
Finisher	1-Stand, 4-High	27″	53″	96″	4500	600	125/250	D.C.	Geared.
Finisher	1-Stand, 4-High	27″	53″	96″	4500	600	125/250	D.C.	Direct.
Finisher	1-Stand, 4-High	27″	53″	96″	3000	600	175/350	D.C.	Geared.
COLD MILLS									
Tandem Mill	4-Stands, 4-High	20½″	53″	54″	(4) 1500	600	300/600	D.C.	Geared. With reels.
Tandem Mill	3-Stands, 4-High	20½″	53″	93″	(3) 1500	600	300/600	D.C.	Geared. With reels.
Skin Pass Mill	1-Stand, 4-High	20½″	53″	93″	1500	600	300/600	D.C.	Geared. With reels.
Skin Pass Mill	1-Stand, 4-High	20½″	53″	93″	250	250	225/450	D.C.	Geared.
Skin Pass Mill	1-Stand, 2-High	28″	—	54″	250	600	500/1000	D.C.	Geared. With reels.
Skin Pass Mill	1-Stand, 2-High	28″	—	55″	250	250	500/1000	D.C.	Geared. With reels.
Skin Pass Mill	1-Stand, 2-High	32″	—	96″	300	440	300	Induction	Geared.

C. L. McGRANAHAN
Asst. Gen. Supt., Pittsburgh Works, Strip and Sheet Division

View of two coilers installed in the hot mill run-out table. They are each driven by five 15 horsepower A. C. motors. From these coilers a conveyor transports the coils of strip to the coil storage room.



circle shear installed in this department. Plate shipping is done directly from this department.

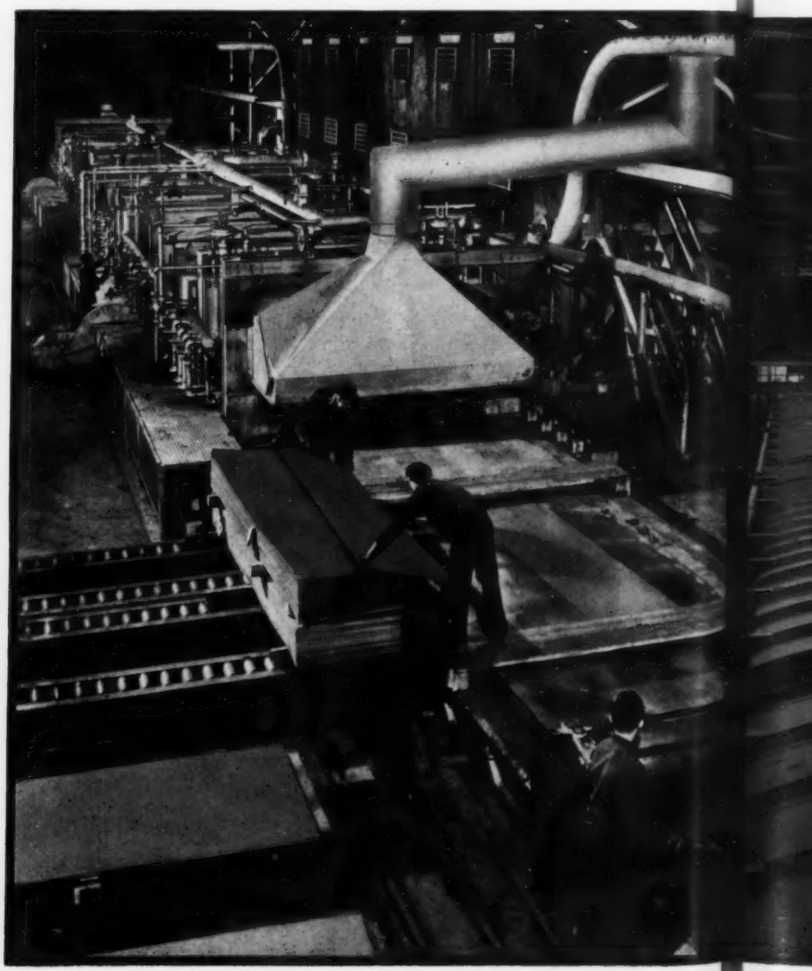
BLUE ANNEALING DEPARTMENT

The blue annealing department is designed to handle black sheets up to 22′–0″ maximum length, 90″ maximum width, and 3/16″ maximum thickness, and pickled sheets up to 18′–0″ x 90″ x 3/16″ maximum dimensions.

Sheets for hot-rolled finishing are handled by crane from the two piling stations on the hot mill runout table, and stored on cast iron skids for cooling. Two 96″ x 3/16″ trimming lines are provided, each consisting of charging table, side trimmer, roller leveller, an up-cut shear, gauger table and piler.

In this department a sheet normalizer has been installed, 108″ in width x 106 ft. in length with a roller type hearth of heat resisting alloy rolls. The heating zone is 60 ft. long, with a 46 ft. cooling zone. Fuel is normally natural gas. Furnace capacity averages about 15000 lb. per hour for normalizing at 1850 degrees F., and about 27000 lb. per hour for blue annealing at

Charging sheets into the normalizing furnace which has an average capacity of about 15,000 pounds per hour for normalizing at 1850 degrees F., and about 27,000 pounds per hour for blue annealing at 1650 degrees F.



1650 degrees F. Speed of sheets through the furnace is varied to suit the material and the specifications.

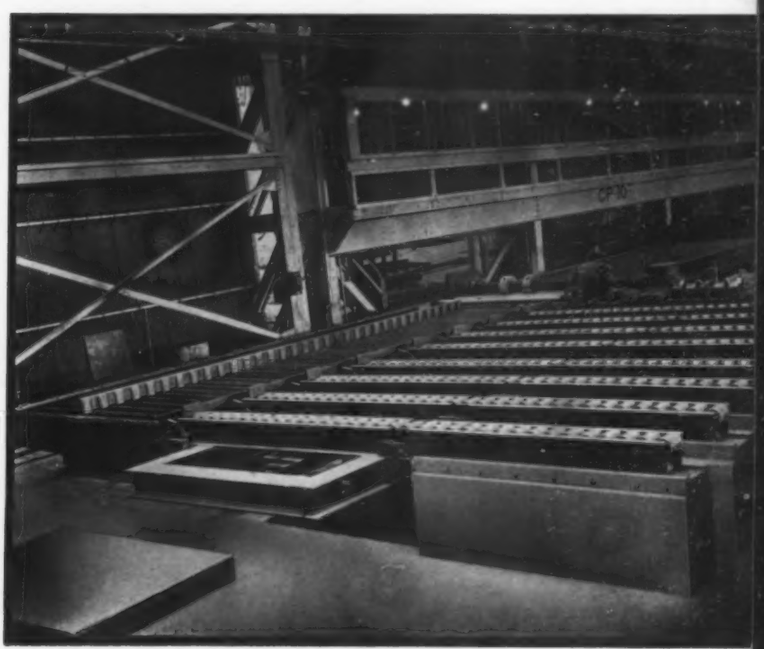
Sheet pickling is performed in this department on a 32″ four-arm vertical plunger mast pickler, using crates 100″ long x 37″ wide. The tanks on this pickler are of concrete construction, lined with impervious brick laid up with acid-resisting mortar. A scrubbing and drying unit is also installed at this pickler.

This department also houses two 2-high skin pass cold mill units, one 28″ x 55″ and the other 32″ x 96″ in size. The former is driven by a 250 H.P., 250 volt, 500/1000 R.P.M., D.C. motor, through gearing which produces roll speeds of 41-82 R.P.M. and sheet speeds of 301-602 ft. per min. It is equipped with an uncoiler and a tension reel, so that either coils or sheets may be rolled. Material of No. 12 gauge or lighter may be handled in coil form, and subsequently cut into desired lengths. The second mill is driven by a 300 H.P., 300 R.P.M., 440 volt induction motor, and is equipped to handle sheets only. Gearing on this stand gives a roll speed of 24.6 R.P.M. and a sheet speed of 206 ft.

View of two continuous pickling lines. To form a continuous chain through the pickling line, coil ends may be lapped and stitched together, or butted and arc-welded, as desired.

WILLIAM MILLER, *Mgr. of Sales, Strip and Sheet Products*

This illustration shows the loading section, pack tilting mechanism, chain driven live roller table located between trimmer and roller leveller of the 96″ cutting line, in the blue annealing department.

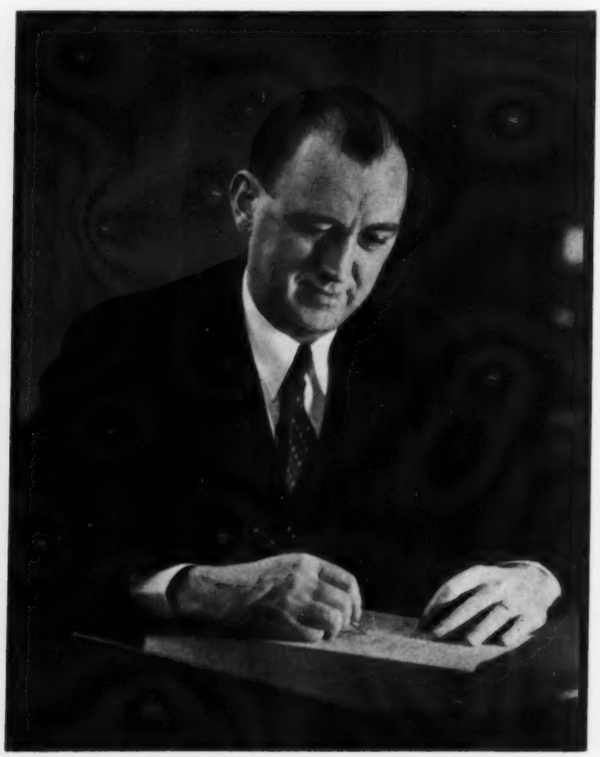


C. W. LITTLER, *Chief Engineer*

H. W. GRAHAM, *General Metallurgist*

J. B. CARLOCK, *Chief Plant Engineer*

J. M. MORRIS, *Supt. of Maintenance, Pittsburgh Works*



per min. The 55″ mill employs babbitted bearings, while bronze bearings are used in the 96″ stand.

Other equipment in this department is as follows:

One 60″ trimming line for cutting sheets from coils, consisting of feed reel, trimmer, leveller, and rotary shear. This unit will cut lengths from 4 ft. to 20 ft.

One cutting unit, consisting of charger, trimmer, leveller, fixed and adjustable shears and a piler.

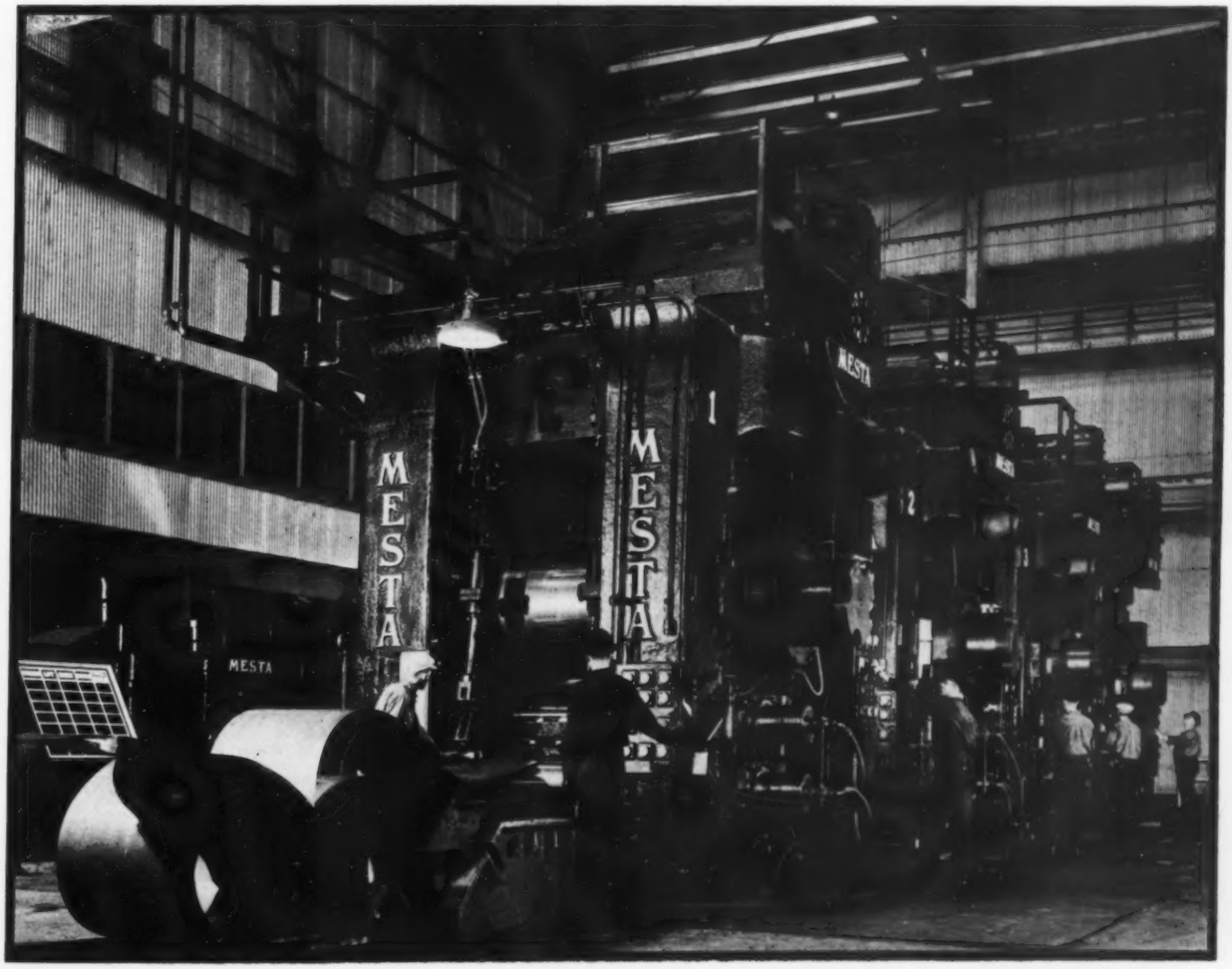
Two 3/8″ x 156″ squaring shears.

Three 3/16″ x 98″ squaring shears.

One 3/16″ x 156″ squaring shear.

In the consideration of the equipment installed in modern strip mill plants, perhaps too little attention is given to various conveyor tables and similar items of equipment, which are so extensively used throughout the finishing departments, and which contribute so greatly to the economy of operations. No considerable ingenuity has gone into the design and application of this equipment, and a brief study will definitely illustrate its importance. A good example is the 96″ cutting line in the blue anneal department. Sheet packs are placed by crane on parallel conveyors of the loading section of this unit, from which they move onto the tilting device, which tilts to an angle of about twenty degrees and brings packs to rest against stops at the end of each parallel conveyor. Sheets are pulled manually one by one from the pack onto the charging table. This live roller unit has both a fixed guard and a movable guard. When sheets are pulled onto the table, they rest against the movable guard which has been set to receive them according to the width of sheet being handled. The rollers of this table are skewed, 1/8″ to the foot, in the direction of the fixed guard, which keeps the sheets squared against the fixed guard as they enter the trimmer. Sheets pass through the trimmer and are discharged onto the chain-driven roller table between the trimmer and the roller leveller. The rollers of this table are also skewed to square the sheets against the fixed guard as they enter the roller leveller, after which another live roller table conveys the sheet to an up-cut shear. Air pushers are applied at the end of this table to square the sheet tightly against the fixed guard. The gauger table, which follows the shear, is provided with a gauger head which can be set for the desired sheet length either by hand or by motor-driven screw. Sheets coming to rest against the gauger head

Feeding the pickled and oiled steel in coil form into the 54″ four-high, four-stand tandem mill in the cold rolling department. Each stand on this mill is driven by a 1500 horsepower motor.



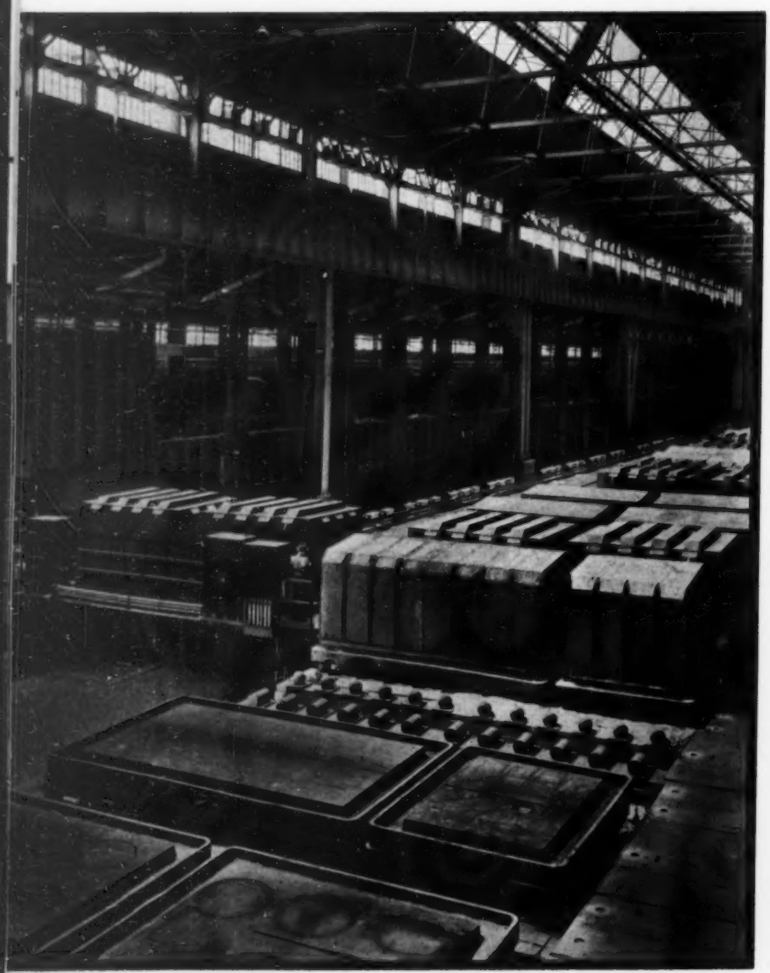
close a limit switch which actuates the up-cut shear. When the sheet is cut, the stop on the gauger head raises to permit the cut sheet to pass on, and then drops again to stop the following sheet. Cut sheets pass from the gauger table to a piling unit, where they are piled and removed by crane. Fibre-tired wheels on the piler bar make sheet piling an easy task, while protecting the sheets from scratches.

COIL PICKLING

The continuous pickling building is 628 ft. long x 70 ft. wide, and lies adjacent to the coil storage building. Here are housed two continuous pickling lines. Each line contains an uncoiler, a processing or scale cracking machine, a shear for trimming coil ends, a stitcher or welder, a looping pit, pinch rolls, and six tanks, followed by pinch rolls, a dryer, a shear for separating the stitching, and a recoiler. To form a continuous chain of material through the pickling line, coil ends may be lapped and stitched together, or butted and arc-welded, as desired. Four of the tanks in each line contain acid solution, with two water tanks following. The former are 58′–7″ long x 8′–6″ wide x 4′–0″ to 4′–4″ deep, with a capacity of about 11800 gallons each, while the latter are 23′–7″ long x 8′–6″ wide x 4′–0″ to 4′–2″ deep, with an approximate capacity of 4750 gallons each. All tanks are constructed of welded $\frac{3}{8}$″ steel plate lined with $\frac{1}{4}$″ thickness of rubber and an inner lining of about 8″ of acid-proof brick laid up in a sulphur base mortar. Each tank has an arched steel cover of $\frac{5}{16}$″ welded plate lined with $\frac{1}{4}$″ of rubber, provided with vents and ducts through which fumes and vapors from the tanks are drawn by rubber-lined exhauster fans of 5000 c.f.m., $3\frac{1}{2}$″ static pressure, capacity, vented to the outdoors.

Acid solutions are normally of about 12% strength, maintained at about 190 degrees F. by automatic temperature controls. Strip speed through the lines may range 76.5-153 ft. per min. Coils are weighed before and after pickling to ascertain loss in the process. From here, pickled coils may proceed through the remaining processes for full finished production or for the Tinplate Department at Aliquippa Works.

Box annealing furnace equipment consists of twenty batch type furnaces arranged in five blocks of four furnaces each, and two radiant tube annealing covers. All are fired with coke oven gas and fully equipped with controls and instruments.



COLD MILLS

The cold rolling of coils is accomplished in two tandem mill trains. The first consists of four 4-high stands, $20\frac{1}{2}$″ and 53″ x 54″, each stand driven through gears by a 1500 H.P., 600 volt D.C., 300/600 R.P.M. motor. Roll and strip speeds in this mill are as follows:

	Roll Speed, R.P.M.	Strip Speed, Ft. per Min.
Stand No. 1.....	34. — 68.	183—366
Stand No. 2.....	55.2—110.4	296—592
Stand No. 3.....	72.3—144.6	388—776
Stand No. 4.....	86.3—172.5	463—926

The second tandem train is composed of three 4-high stands, $20\frac{1}{2}$″ and 53″ x 93″, each driven by a motor duplicating those of the four-stand train. Roll and strip speeds in this mill are the same as for the first three stands of the four-stand mill.

The mill stands on both tandem trains are spaced on 16 ft. centers. Anti-friction bearings are used on work rolls, with oil-flooded bearings on the back-up rolls. Each train is preceded by a coil box and is followed by a tension reel for re-rolling the strip. Full cold rolling usually calls for a gauge reduction of approximately 60%. Continuous micrometer gauges insure accurate strip thickness, and strip tension indicators aid in the proper cold mill operation. The two tandem trains have a nominal capacity of 30000 tons per month.

D.C. power for the tandem mills comes from two dual motor-generator sets located in the cold mill substation, each consisting of two 1750 K.W., 600 volt D.C.

generators driven by a 3900 K.V.A., 500 R.P.M., 6600 volt, 25 cycle synchronous motor. Mill stands of each respective tandem train are synchronized through Ward-Leonard control systems.

ANNEALING

Box annealing may be done with material in either sheet or coil form. Furnace equipment consists of twenty batch-type furnaces arranged in five blocks of four furnaces each, and two radiant tube type annealing covers. The former are 14′–10″ x 27′–6″ inside dimensions, and will each accommodate two boxes. The radiant tube furnaces are 9′–6″ x 20′–6″ and 13′–6″ x 19′–6″ respectively, the former being used for sheet material and the latter for coils. Each cover is provided with four bases.

All annealing furnaces are fired with coke oven gas, and are fully equipped with controls and instruments.

The batch furnaces are served by a specially designed charging machine which runs on a track paralleling the furnace row. Loaded boxes are picked up from loading stations and charged into the furnaces. Hot boxes are removed from the furnaces and placed at cooling stations located opposite the furnaces.

Two gas conditioning units, each of 15000 cu. ft. per hr. capacity, provide deoxidizing gas for atmosphere control in the boxes.

COLD FINISHING

There are three skin pass mills also installed in the cold rolling department, in which a reduction of one to three percent may be given box annealed material in order to obtain good surface and modified physical characteristics. The first of these is a single 4-high stand, 20½″ and 53″ x 93″, equipped to handle either sheets or coils, and driven by a 1500 H.P., 300/600 R.P.M., 600 volt D.C. motor. This stand is geared so as to obtain roll speeds of 72.3-144.6 R.P.M., and strip speeds of 388-776 ft. per min. A second stand, also 20½″ and 53″ x 93″, is arranged for sheet rolling only, and is driven by a 250 H.P., 225/450 R.P.M., 250 volt D.C. motor. Gearing on this stand is such as to give roll speeds of 108.4-216.9 R.P.M., and sheet speeds of 137-274 ft. per min. There is also a single 2-high stand, 28″ x 54″, arranged for either sheets or coils, driven by a 250 H.P., 500/1000 R.P.M., 600 volt D.C. motor. Roll speeds on this stand are 41-82 R.P.M., with strip speeds of 301-602 ft. per min. All of the temper mills are followed by roller levellers, piler, and the necessary tables, while those in which coils are rolled are also provided with a feed reel and a tension reel. The 4-high stands have oil-flooded bearings on the back-up rolls and anti-friction bearings on the work rolls. The 2-high mill employs babbitted bearings.

The 250 volt D.C. drive mentioned above draws its power from the general D.C. system, while the other two drives are powered from a dual motor-generator set consisting of one 1500 K.W. and one 400 K.W., D.C. generator, 600 volts, driven by a 2200 K.V.A., 500 R.P.M., 6600 volt synchronous motor. This set is also located in the cold mill substation, which also houses a 2000 K.W. motor generator set supplying 250 volt auxiliary D.C. power and an open-delta bank of two 1000 K.V.A., 6600/440-220 volt transformers supplying auxiliary A.C. power. An underground tunnel, in which are located the bus bars connecting the substation to the cold mill drives, also serves to convey the air for motor cooling.

Space has been provided for two more skin-pass mills, to be installed if future developments should require added capacity in this department.

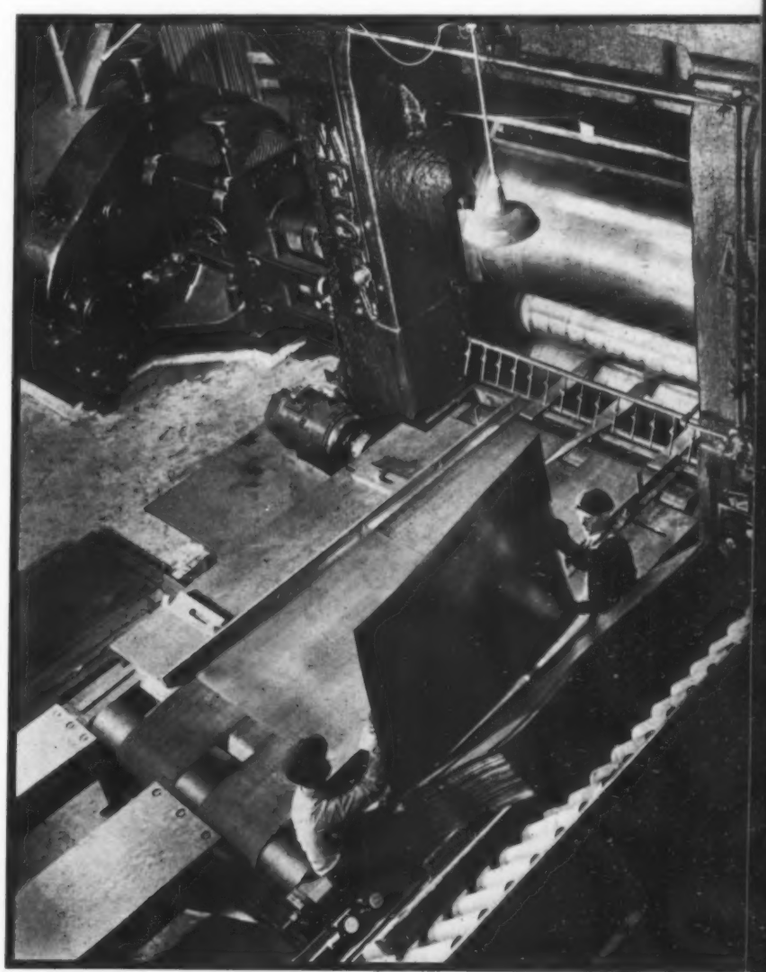
Other equipment in the Cold Rolling Department includes:

Two 93″ shearing lines, consisting of feed reels, trimmers, combination flying shears and levellers, manually operated pilers, and gravity tables.

One 93″ trimmer and slitter, consisting of feed reel with drag device, slitter and trimmer and tension reel for 20″ and 28″ diameter cores.

One 76″ shearing and trimming unit consisting of

To prevent the stretcher strains from forming and to provide the right stiffness in the finished product the steel is given a temper pass, or skin pass in the 93″ four high, single-stand mill.



feed reel, trimmer, combination flying shear and leveller, manually operated piler and gravity table.

One 93″ roller leveller unit.

One stretcher leveller and flat table.

One 3/16″ x 98″ squaring shear.

Three 3/16″ x 156″ squaring shears.

GALVANIZING DEPARTMENT

The galvanizing department, located at the extreme down-river end of the strip mill group, is set up to handle sheets of No. 10-No. 31 gauge, up to 60″ wide and 180″ long. An oscillating type pickler is installed, consisting of two acid tanks and four rinse tanks, with two acid measuring tanks. Automatic temperature control is employed on this pickler. The galvanizing machine has a speed range of 10-160 ft. per min., and is provided with a fume collecting system through which fumes are discharged above the roof from an exhauster fan. The galvanizing furnace is heated with coke gas and is provided with automatic temperature control and a fan for combustion air. A 66″ feed table and feeding device precedes the machine. From the galvanizing machine, magnetic rollers convey sheets to a cooling conveyor. Following this, the sheet is roller levelled, washed, dried, and again roller levelled.

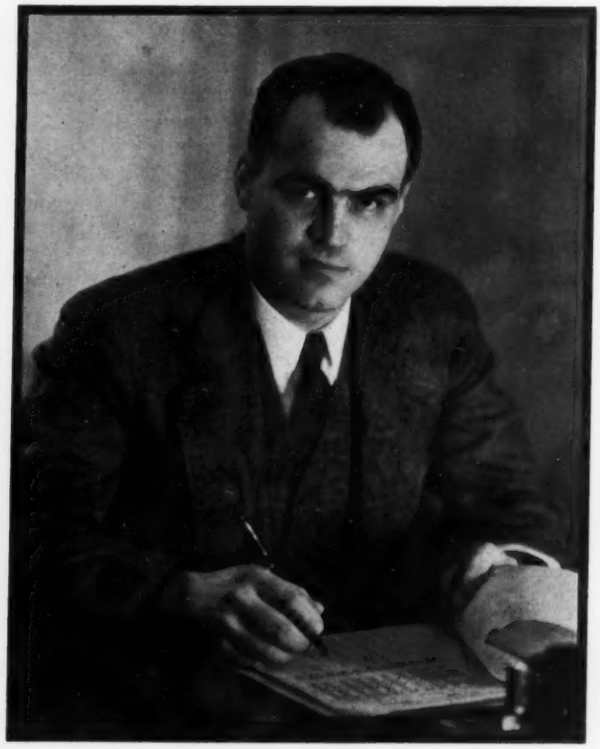
Additional equipment in this department includes the following:

One 12 ft. continuous roller type roofing corrugating

L. E. FEISNER, *Supt. 96″ Hot Strip Mill*

J. R. BOTTOMS, *Supt. 93″ Cold Strip Mill*

R. E. O'BRIEN, *Supt. Galvanizing Dept.*



machine equipped with 1¼", 2½" and 5" crimp dies.

One 170" roller type corrugating machine equipped with 2½" culvert dies.

One corrugated culvert curving roll machine.

One band corrugating machine, which provides bands for securing bundles of corrugated sheets.

One brick siding machine.

One sheet metal printing machine.

LUBRICATION

Three separate oiling systems are used on the hot mill, each with its own storage tank, automatic pumps, filters, centrifuge and cooler. One system, of 350 G.P.M. circulating capacity and 16000 gallons storage capacity, lubricates the back-up roll bearings. Reduction gears, with their bearings, are served by the second oil system, of 350 G.P.M. circulating capacity and 7500 gallons storage capacity, while the third system, 225 G.P.M. and 8000 gallons capacity, takes care of the pinion bearings. These systems are located in the cellar between the mill and the motor room, and oil is distributed to points of application by piping systems running in a tunnel under the pinion stands. Returns to the systems are by gravity. Complete interlocking and alarm devices have been applied.

Five separate automatic pressure grease systems are also used on the hot mill, lubricating respectively the slab furnace equipment, the mill tables, the work roll bearings, the runout table and coilers, and the pilers and approach table.

Cold mill lubrication is provided principally by two oil systems similar to those on the hot mill, but of 240 G.P.M. circulation rate and 8000 and 6000 gallons storage capacity respectively. The former serves the back-up rolls of the mills, while the latter takes care of reduction gears, pinions and bearings. A third small system supplies the skin pass mill located in the blue

This galvanizing unit is set up to handle sheets of No. 10–No. 31 gage, up to 60" wide and 180" long. Black sheets are given a tight bond coating of hot zinc (galvanized) and carefully inspected by trained operators.

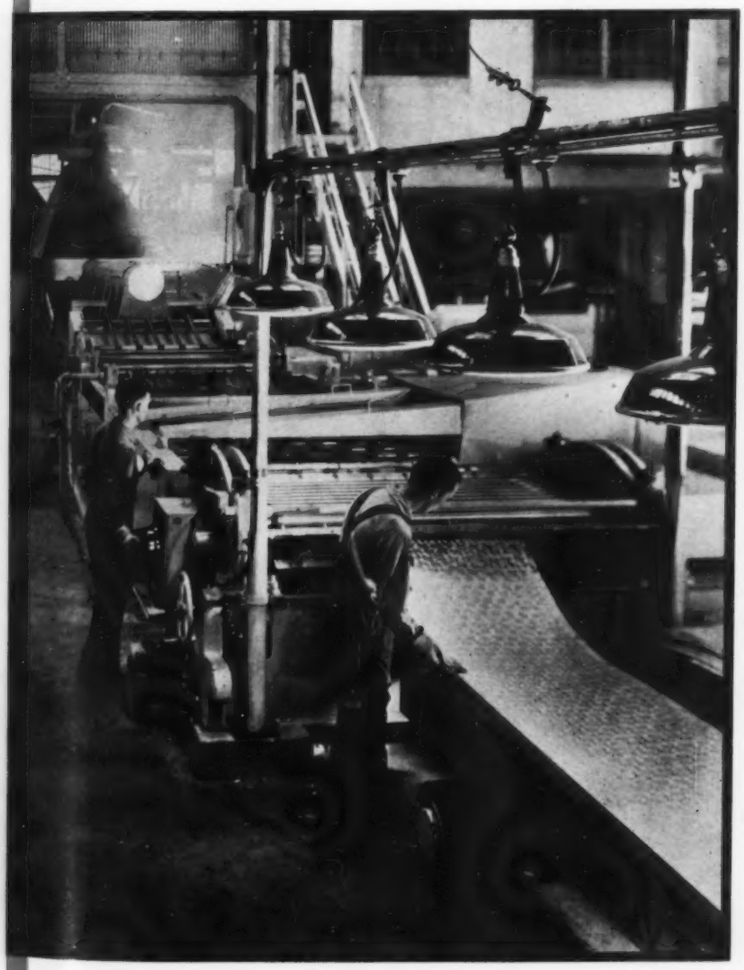
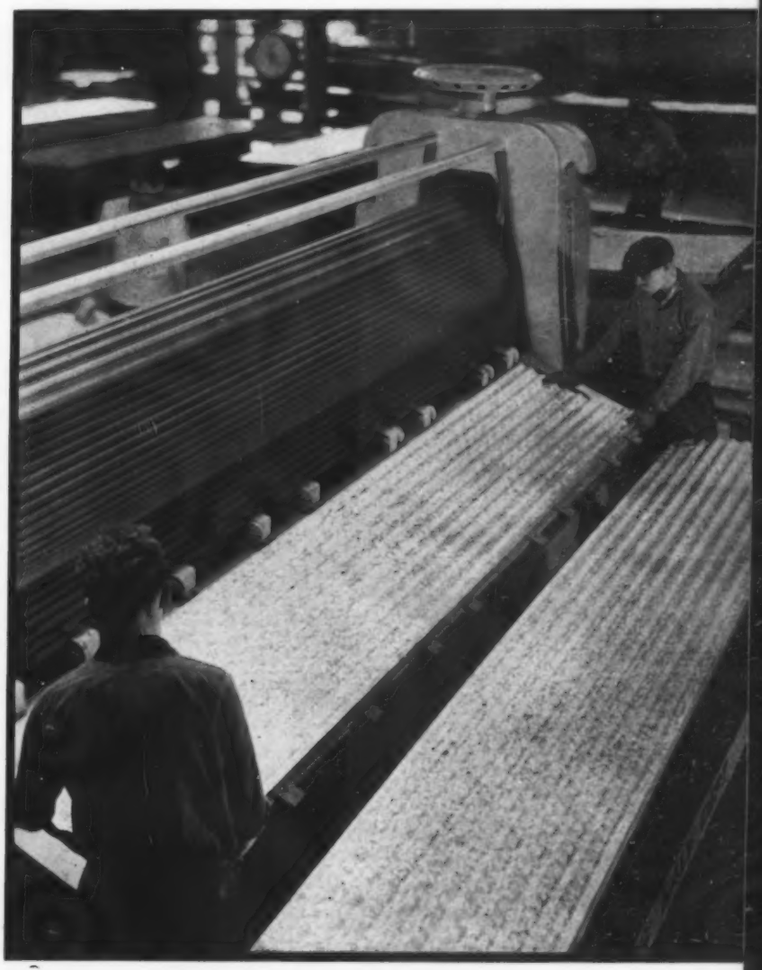
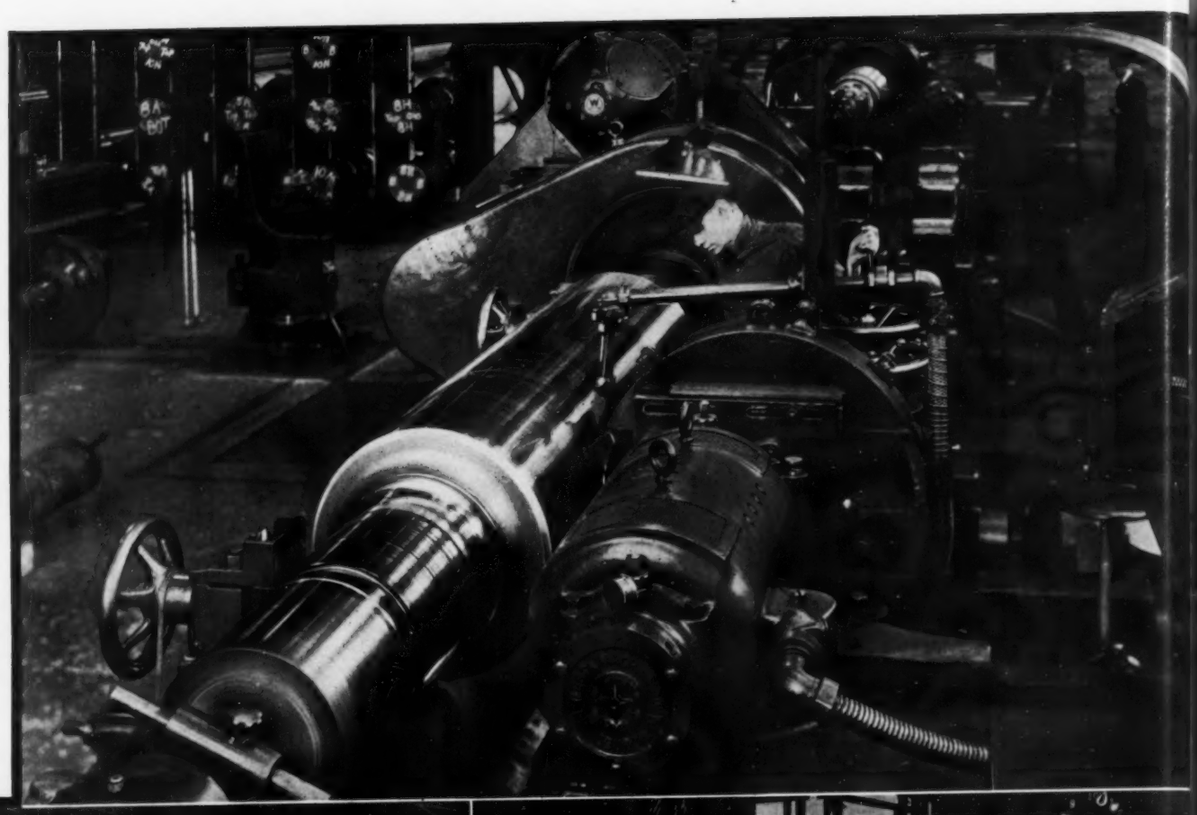


Illustration of corrugating galvanized sheets. This department also includes the other necessary equipment for turning out various types of corrugated products.





MESTA
9

As depicted at the left, speed and rapidity in changing of rolls on this new mill are very necessary items to insure the least of uninterrupted production. The care of the rolls is also important, and two special shops are provided, one taking care of the rolls for the hot mill, and the other the cold mill. These departments include one roll lathe, four roll grinders, a shear knife grinder, a roll transfer, and the necessary roll racks.

annealing department. A pressure grease system lubricates work roll bearings on the cold mills. Levellers, trimmers, shears, and miscellaneous equipment are lubricated with hand-operated pressure grease systems.

CRANES

The entire plant is served by twenty-four overhead traveling cranes, all of which are equipped with anti-friction bearings with the exception of the motor room crane. Crane data is as follows:

Location	Number	Capacity, Tons	Span, Ft.-In.	Lifting Magnet Controls
Slab Yard	2	25/15	93–6	2
Motor Room	1	50/10	58–6	—
Hot Mill	2	75/25	83–6	2
Plate Fin. and Ship.	2	15	88–6	2
Hot Finishing	2	20	108–6	2
Blue Anneal	3	20	108–6	3
Con. Pickling	1	15	63–6	1
Coil Storage	2	15	63–6	2
Batch Anneal	1	30/15	98–6	—
Cold Mill	1	75/25	108–6	—
Cold Mill	1	30/15	108–6	—
Finishing Dept.	2	15	83–6	—
Shipping	2	15	93–6	—
Roll Shop	1	60/10	53–6	—
Galvanizing	1	15	98–6	—

SERVICE DEPARTMENTS

Electric power is supplied to the strip mill from the company's own generating plant at Eliza Furnace Works, at 6600 volts, 25 cycles. A summary of the 6600 volt connected load of the strip plant accompanies this article. Summation of the rotating electrical machinery in the plant is approximately as follows:

	Number	Total H.P.
Motors—Hot Mill	1871	62,680
Generators—Hot Mill	18	32,000
Total—Hot Mill	1889	94,680
Motors—Cold Mills and Finishing	366	20,277
Generators—Cold Mills and Finishing	8	15,200
Total—Cold Mills	374	35,477
Grand Total	2263	130,157

SUMMARY OF CONNECTED LOAD

	K.V.A.
No. 1 Scalebreaker	
1000 H.P. x .746, @ 91.5% P.F.	814
No. 1 Broadside	
3000 H.P. x .746 @ 91.8% P.F.	2440
Nos. 2, 3 and 4 Roughing Stands	
3 x 3000 H.P. x .746 @ 87% P.F.	7710
Finishing Mill Motor-Generator Sets	
3 @ 6500 K.V.A.	19500
Spray Pumps	
2 x 1250 H.P. x .746 @ 90.5 P.F.	2056
Auxiliary Motor-Generator Sets	
2 @ 2100 K.V.A.	4200
1 @ 2800 K.V.A.	2800
Cold Mill Motor-Generator Sets	
2 @ 3900 K.V.A.	7800
1 @ 2250 K.V.A.	2250
Auxiliary Power Transformers	
2—1000 K.V.A., open delta	1740
3—1000 K.V.A., delta	3000
Air Compressors	
2—600 H.P.	912
Total 6600 Volt Load	55222 K.V.A.

Steam is supplied from the blast furnace boilerhouse located nearby. Quantities up to a maximum of 225,000 lb. per hr. may be required for processing and building heating.

Water for hydraulic purposes comes from two 7-stage centrifugal pumps rated at 1200 lb. per sq. in., 1200 G.P.M., each driven by a 1250 H.P., 6600 volt, 750 R.P.M. induction motor. Service water is obtained from the Monongahela River, and approximately 24800 G.P.M. are required for the strip plant.

Two roll shops are provided, one taking care of the rolls for the hot mill, the other servicing the cold mills. The former includes one roll lathe, two 60″ x 20 ft. roll grinders, a shear knife grinder, a roll transfer, and the necessary roll racks. The cold mill shop includes one 28″ x 16 ft. roll grinder and one 60″ x 24 ft. roll grinder.

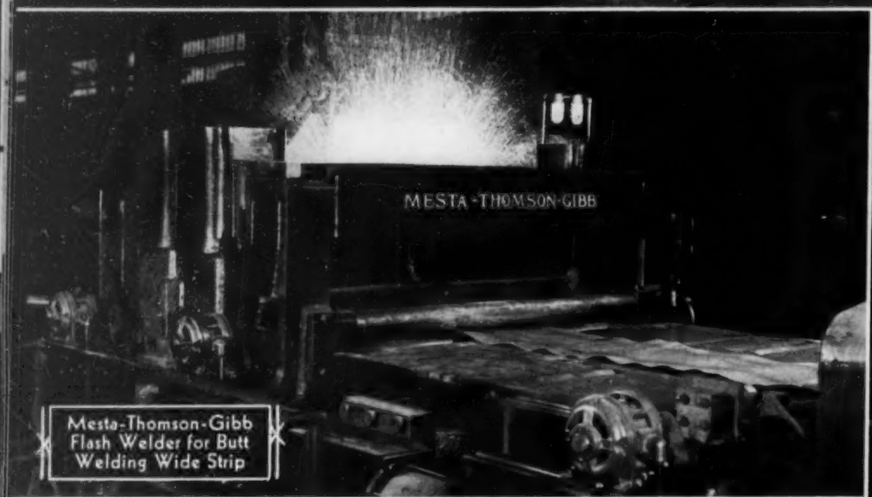
A machine shop, a wood-working shop, and an electrical storeroom are located in the cold finishing building, adjacent to the cold mill sub-station.

Built by

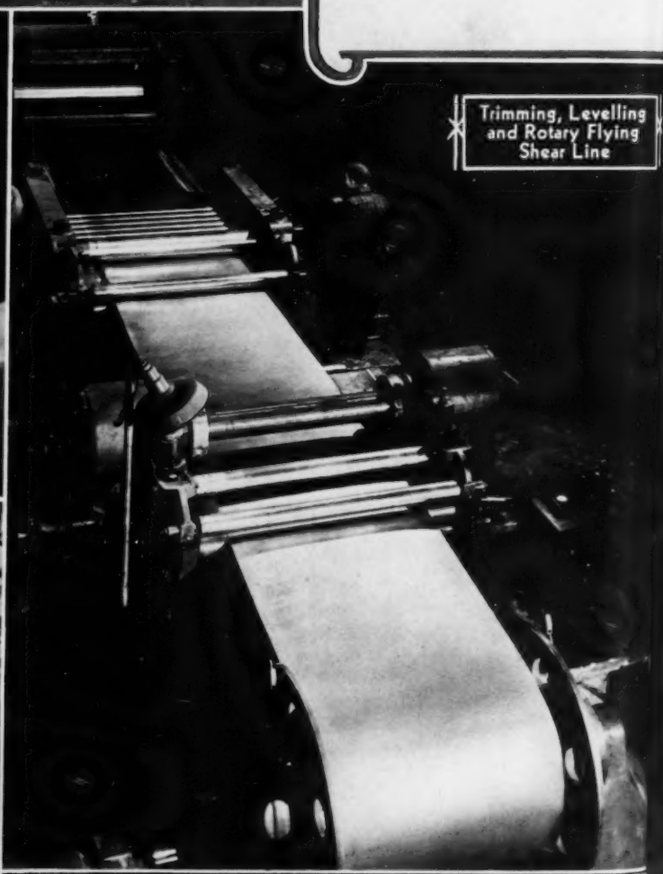
for the

JONES &

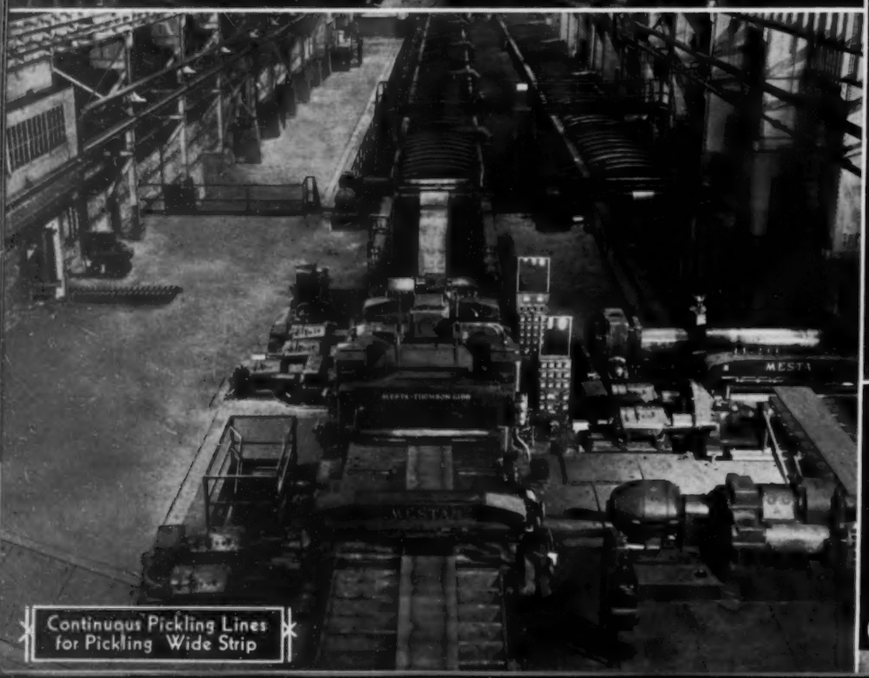
Finishing Stands
96" Four High Continuous
Hot Strip Mill



Mesta-Thomson-Gibb
Flash Welder for Butt
Welding Wide Strip



Trimming, Levelling
and Rotary Flying
Shear Line



Continuous Pickling Lines
for Pickling Wide Strip

MESTA MACHINE CO.

ADVERTISING PAGES REMOVED

DEVELOPMENTS *in* WELDING DURING 1937

By G. A. HUGHES
Chief Electrical Engineer
Truscon Steel Company
YOUNGSTOWN, OHIO

Presented before the A. I. & S. E. Annual Convention, Chicago, Illinois, September 28, 29, 30, October 1, 1937

▲ AT the end of former years it has been easy to catalog the outstanding achievements of welding and to be sure the entire field was covered and nothing of importance was omitted. It is now difficult to describe the latest developments or to review recent developments in the field of welding. There are over ninety manufacturers of welding equipment and more than thirty thousand people directly interested in welding, with over one hundred universities teaching welding or holding welding symposiums which is causing such a rapid change in our methods that our periodicals are lagging about six months behind in their endeavor to report the latest developments in the field of welding.

The electric arc welding method, Oxy-acetylene and Resistance welding process have become as indispensable in our modern method of industry as the electric motor or high speed machine tools.

All the possibilities and advantages of welding are not yet made use of and many more products will be fabricated by some of the various methods of welding in the future. Many barriers are yet to be broken down. Traditions of long standing are not easily overcome and it will take an educational program to obtain this. Our universities are now working on a program of research that in a few years will have all information on fatigue in welded joints which will permit the use of all welded lattice girders in bridge construction. One research problem is the calculating of shrink stresses before welding.

Developments in arc welding during the past year have been largely confined to improvements of existing equipment and extension of its application. Single operator welding generators have undergone refinement in design and construction which result in increased stability and ease of operation. Gasoline engine driven single operator welders are now furnished with Ford V-8 engines on the popular 200 and 300 ampere sizes, resulting in lighter, more compact, and more easily serviced units.

Automatic atomic hydrogen arc welding applications have been extended; one unit recently built has nine separate atomic hydrogen arcs in one head.

Progress in the electrode field has been steadily toward higher deposition rates, greater dependability, and even better physical characteristics.

Possibly the most noteworthy factor in the welding picture today is the enormous increase in demand for both equipment and electrodes, following the very great increase in steel consumption noted in the past year.

Worthy of note is the fact that New York City's Building Codes now recognize arc welding as a means of fabricating steel structures within the City. This factor will undoubtedly have considerable influence on the development of arc welding in the structural field.

In this connection, it is interesting to note that the New York State Armory at Schenectady, N. Y., now being erected, is to be entirely arc welded. This building has the largest welded plate girder and the largest welded arches of any building in the United States.

There are ninety-six bridges and twenty-eight hundred seventy-one buildings partially or wholly welded in the United States.

ELECTRODES

Every manufacturer of electrodes during the last year has placed on the market new electrodes giving greater speeds, better durability and increased ultimate tensile strength. Some electrodes giving over one hundred thousand pounds ultimate tensile. This is a most welcomed electrode for the steel mill maintenance men. Some of these new coated electrodes give the very low cost of 0.17 per pound weld metal deposited.

The splatter loss is very low and is a universal rod for AC or DC welders—straight polarity for direct current machines.

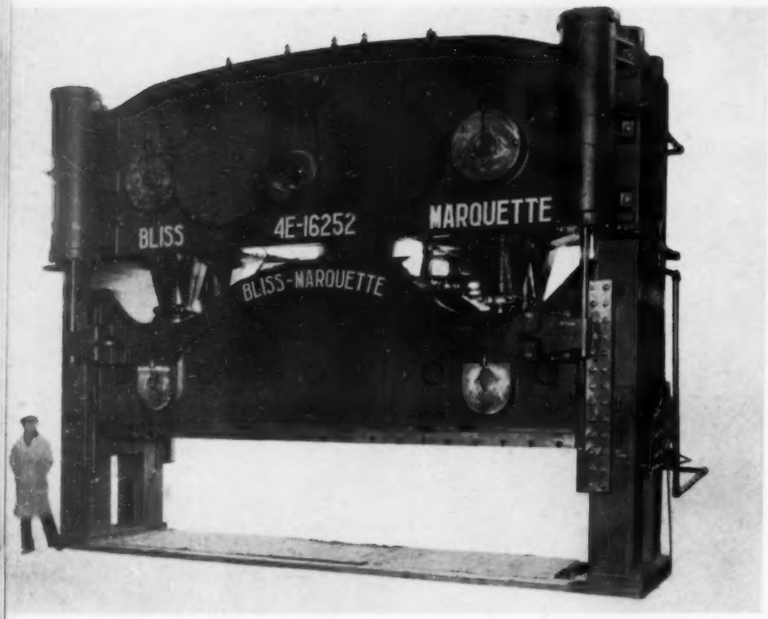


Figure 1—An example of what can be done with steel plate and metallic arc. The total weight of this press is 750,000 pounds.

WELDING—SHIP BUILDING

During the meeting of naval architects at Chester, Pa., June 22nd of this year, there was a favorable attitude by all present for welded construction. Mr. Robert Haig, Vice President of the Sun Shipbuilding Company was of the opinion that arc welded construction would replace to a large degree riveted construction, giving his reasons for his opinion. Mr. J. W. Powell, President of the United Ship Yards, Inc., New York, shared his views as regarding welded construction in Shipbuilding. There was no dissenting opinion among those present and all were very favorable to welded construction.

The past year has seen the beginning of the application of welding to Shipbuilding.

It has taken twenty years for those advocating welding to accomplish their undertaking. Welding is no longer regarded as a novelty and with suspicion but a normal process to be used by the shipbuilder where he finds it economical.

In 1917, the Interned German ships were repaired by arc welding and put in service in a few months time. The crews of these ships damaged the engines thinking it would take twelve to sixteen months to repair and get the ships in commission.

In 1918 a few barges and river boats were built by welding and after twenty years, we find welding coming into its own.

The Great Lakes Engineering Works launched the second arc-welded ship, the largest ever built in the ship yards "All Welded". The ship is 300 feet long, 43 feet wide and 20 feet deep.

The Racing Yacht Ranger, Mr. Vanderbilt used in defending the International Racing Cup, this summer, had an arc-welded keel and arc welding was used extensively throughout. The yacht is 135′ 6″ long and 21 feet wide with a 15-foot draft.

FABRICATION OF HEAVY MACHINE PARTS

Mr. D. B. Charters of the Westinghouse Company assisted by Mr. F. J. Rode of the Bliss Company, reports the fabrication of heavy press parts which is of great value to those interested in welding and its progress for 1936–1937, and offers good examples of what can be done with steel plate and the metallic arc.

Figure 1 will give an idea of the size of the job. However, the largest unit is hidden entirely below the floor level. The overall height of the press is 348¾″, length 338″, the width is 147¾″, and the total weight complete is 750,000 pounds. The working capacity is 1800 tons plus the cushion load of 300 tons. The bed of the press is 252″ long between housings and 68″ front to back, and in order to avoid deflection was designed for a load of 2500 tons.

The press is capable of bending two car rails of $\frac{5}{32}$″ material, 200″ long at one stroke, the web to be flat within .005″ and the flanges at right angles to the web. The working load is taken by 4—9″ alloy steel through bolts extending up inside the uprights, the parts of each unit being so placed that the major portion of the stresses are absorbed without unduly stressing the welds. For considerations of strength, all welds heavily stressed were made with coated rod, which necessitated positioning of the weld.

Heavy fillet welds, made with coated rod, require positioning of the part to obtain speed in welding. Because of the size of these parts butt welds were used insofar as possible, so that welding could be done with the work in a horizontal position. Up to 1″ butt welds there is little to choose between a burned and a machined preparation, the additional cost of a machined preparation being over-come by the speed obtained in welding because a large wire can be used from the start. On welds larger than one inch the machined preparation is preferable because of the reduced area of the weld to be laid. That is, of course, not an invariable rule by applies particularly to welds of reasonable length. The procedure as outlined above governed the welding preparation on the job with which we are concerned.

The bed of the press is the largest piece, 338″ long, 120″ wide over the feet with a depth of 120 inches, the rough weight 157,000 pounds. Figure 2 shows the bed completely welded and partially machined. The side

Figure 2—The bed completely welded and partially machined.

plates were 5″ thick and the curved rib attached to the bottom of the plate was 9″ x 12″ in cross section. One weld preparation was machined on this bar before bending, and the other preparation was burned on the curved portion of the side plate. This welding was done before assembly as was the attachment of brackets and pads on the inner side of the bedplates. Figure 3 shows how the bed was made up of partial assemblies so far as seemed practical.

The structure was strain relieved before attaching the supporting feet, principally because it was difficult to handle with the feet attached and since the feet carried only the dead load, peening of the welds on the feet was deemed sufficient.

Figure 4 shows the crown in process of assembly. The bosses, pads and lettering was done on each of the individual side plates before assembly so that down hand welding could be used. The bosses were of cast steel, turned to a light shrink fit in the side plates, the plates themselves being bored and machined for the weld. Immediately above and to the left of the man in the picture can be seen the space for the upper compression member. As mentioned before, the heavy load stresses are taken in compression through the members and not through the welds, the location of the member and the burned weld preparation being clearly visible. Space will not permit discussing this in detail or to name all the machines fabricated by arc welding during the year. Maintenance men in the steel industry have mailed in many interesting articles on repairs made by welding, but again time will not permit us to give them at this moment.

WELDING ON ELECTRIC LOCOMOTIVE MOTOR FRAMES

The Pennsylvania Railroad have in service a high speed electric locomotive for the heavy passenger service between New York City, Philadelphia and Washington. These locomotives are powered with six twin armature motors. These locomotives were built in the Westinghouse Shops and the motor frames fabricated by arc welding.

Weight, strength and space are the three governing factors in the motor frame design. Figure 5 shows the complete frame, strain relieved, ready to be machined. A little study of this picture will indicate what a formidable casting job it would be, with its thin and thick

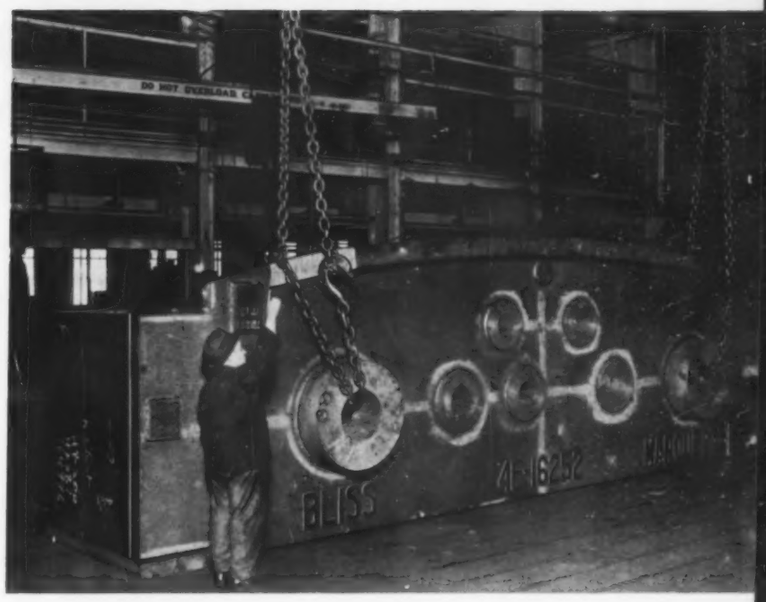


Figure 4—The crown in process of assembly.

Figure 5—The complete frame, strain relieved, ready to be machined.

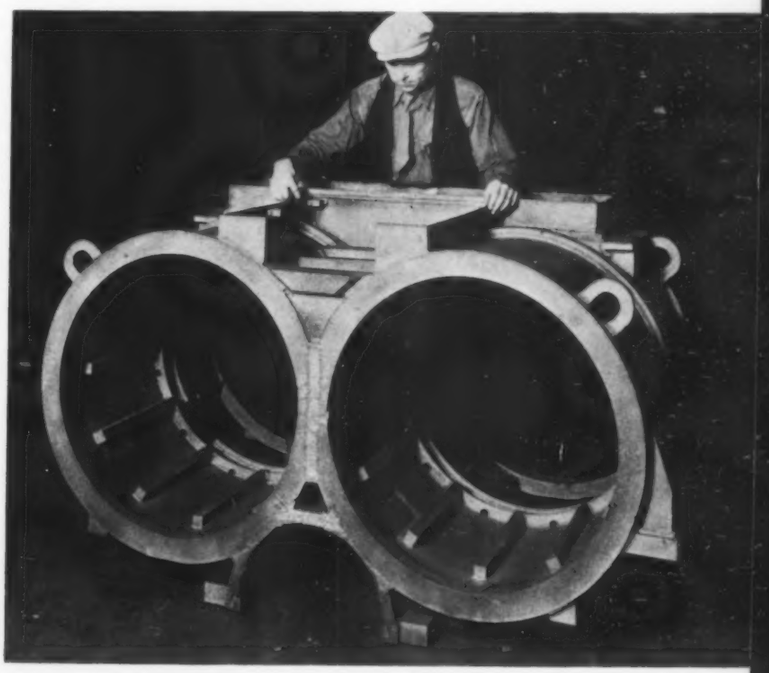
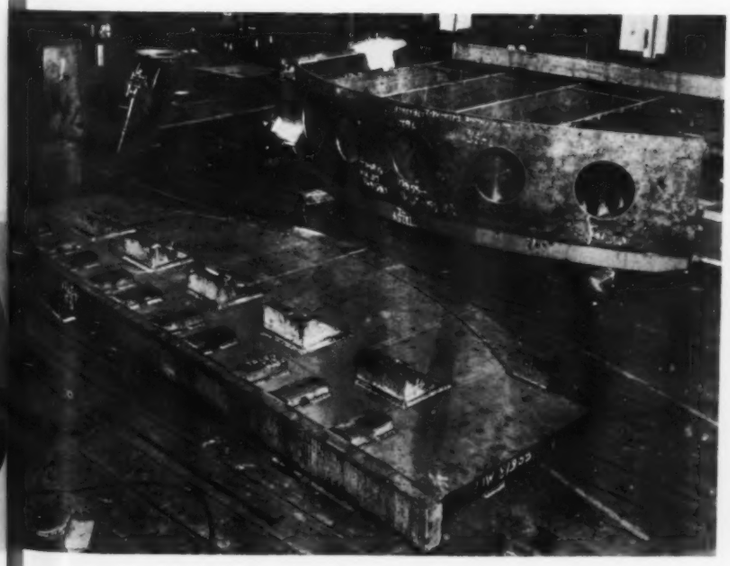
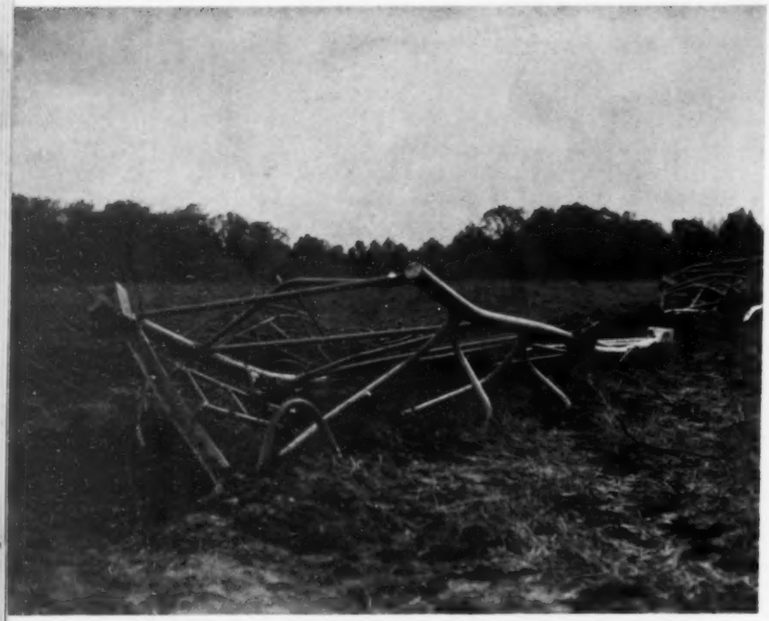


Figure 3—Method by which the bed was made up of partial assemblies so far as seemed practical.





View of antenna tower which toppled from the result of a defective guy strand socket.

sections and generally complicated made structure. The outside fillet welds were made on an automatic arc welding machine.

SAFE ENDING BOILER TUBES

A great saving is made by repairmen with use of resistance welding ends to old tubes in boilers, both in locomotive and stationary boilers. The tubes are removed from the boilers, the ends of the tubes cut off and a new end six or eight inches welded on one end and the tube is again ready for service. It saves the cost of a new tube and the cost per weld is exceedingly low.

Thus the locomotive repair shops lower the cost of boiler repairs and the maintenance men of boiler shops in the steel industry will be repaid if they investigate this safe ending of boiler tubes by resistance welding. It is not in the experimental state as it is already being extensively used by our railroad repairmen.

SEVERE WELDING TEST—KDKA ANTENNA TOWER

Radio and structural engineers are greatly interested in the reconstructed vertical radiator or antenna tower of Westinghouse Station KDKA at Saxonburg, Penna. It is of uniform, triangular cross-section throughout its height of 710′ above ground and uniquely constructed of solid structural rounds, shop welded into unit length columns assembled end to end in the field by means of bolted butt joints. A fair idea of the preponderance of welds may be gained from the fact that only about 400 heavy assembly bolts are used in the field whereas upward of 4400 electric arc shop welds were required to fabricate the tower.

It is the tallest man-made structure ever fabricated by means of electric arc welding and includes many design features of interest to engineers. It is supported by two sets of extra high strength galvanized steel guys and designed to withstand 100-mile per hour indicated velocity wind from any point of the compass. It is insulated from ground at its base by a double cone insulator, also at approximately half its height to allow sectionalizing by means of a load coil.

The total weight of the mast proper is approximately 50 tons, half above and half below the sectionalizing insulators.

The electrodes used in shop welding were the heavy flued type and the welders Flexarc of 400 ampere capacity. Since some of the main members are extremely heavy, up to $3\frac{5}{8}''$ diameter, closed welds incorporating fillets with radii up to $1\frac{1}{2}''$ were used. It might be mentioned that the average material thickness is equivalent to that of a conventional angle structure designed for the same purpose, consisting of angles with legs approximately one inch thick, and the unusual resistance to corrosion thereby offered reduces maintenance to a minimum.

The original tower, exactly the same as the rebuilt structure, had been erected to approximately 640′ when a defective guy strand socket in one of the upper cables failed on October 30, 1936. The unbalanced load from the remaining two upper guys produced immediate failure of a second defective socket in one of the lower guys and the entire structure fell to the ground. The terrific impact of the fall from heights as great as 640′ completely buried under ground 5′ 6″ triangular members as illustrated by the accompanying photographs.

Over 200′ of the lower portion of the structure was intact despite the teriffic impact caused by the height of the fall.

A remarkable feature was that over 200′ of the lower portion of the structure was intact and due to the rigidity of the construction, no member was even slightly bent.

Main members up to 3⅝″ diameter solid rounds were completely severed at points away from web system welds and web members were likewise torn asunder without developing a single defective weld out of the total of some 3800 welds subjected to a test impossible to duplicate in any laboratory.

Competent and respected structural engineers still exist who are skeptical of welding, a typical reaction being as follows: "All of the testing and research has been of a laboratory nature, and not based on production welding".

We wish to direct the attention of this minority group of structural engineers and other engineers who share such views in opposition to welding to the KDKA antenna tower.

The fabrication of this mast was a production welding job, similar to 130 others of similar construction now in actual service. With further reference to the photographs, it will be noted that while many members were so twisted as to resemble pretzels and in several cases completely severed, not one weld failed.

Immediately following the disaster, the designs were checked by a number of capable engineers, several of whom were disinterested parties, and the design as originally fabricated was approved for reconstruction with the single exception that prooftesting of guy assemblies was strongly recommended and the recommendation adopted. The replacement has been completed and it is confidently anticipated that no further trouble will be experienced.

Aside from the welding features herein discussed, it is felt that many engineers will be interested in inspecting the completed radiator. Saxonburg is a few miles south of Butler, Pa., and also easily accessible from Pittsburgh. Anyone making the trip to the station will be well repaid for the time he spends to inspect this antenna tower.

STRESS RELIEVING OF WELDED WORK

Fusion welding produces residual or "locked up stresses" caused by unequal heating and cooling of the parent metal and the weld metal. This stress will depend upon the type and design of the joint the welding procedure and shape of parts welded.

These stresses can be removed by annealing or peening. During the last year many articles have been written on "Stress relieving of Welded Structures" those interested can obtain valuable information on the subject through the American Welding Society.

MORTON DISCUSSION

(*Continued from page 40*)

ating couple approaches nearer to the actual temperature of the incoming air but is still relative. Does this answer your question, Mr. Thompson?

LINN BRADLEY: Not having harbored the thought that I might be invited to comment upon Mr. Morton's excellent paper, I came here quite unprepared to do so. Indeed, I had no advance knowledge relative to the ground Mr. Morton planned to cover. However, I freely confess that I was impressed by the boldness, the courage, and the persistence exhibited by Mr. Morton, particularly with respect to the erection of one refractory arch above another and continuous passing of highly heated gases through the channel between them. Action of this character emboldens others to carry on. Similar points can be made as regards his successful employment of what others—less bold—facetiously referred to as chinaware, and also his proposals for radically altering open hearth furnaces and appurtenances. Truly, we live in an age calling for imagination coupled with an enlightened courage and rugged initiative.

I was somewhat disappointed by his failure to include some heat transfer data pertaining to recuperators in which these new refractory tile have been in service. Perchance he will supply these missing links ere long, thereby enriching the literature of the up-and-coming specialty—high temperature heat engineering.

Listening to the remarks of Dr. Bradley, I was again impressed with the need for greater care in the determination of temperatures. Forsooth, the belief has been growing that the literature is loaded with temperature records that mean little, insofar as accuracy is of importance. Unless one knows how and when and where temperatures are taken, it is difficult if not impossible to interpret the data properly. Indeed, they may mislead. Particularly is this true when one attempts to make an energy balance or to compute the thermal efficiency of a furnace. Hereafter, it behooves contributors to literature bearing upon high temperature operations, to privilege us to delve a bit farther beneath the surface, by fully and accurately recording the pertinent facts and data.

Mr. Morton's interesting and informative paper, likewise the prepared discussion, are pregnant with thought provoking ideas; but I feel that I must not take any more time for commenting thereupon.

Developments in THE IRON and

W. H. BURR

▲ UNCERTAINTY of international affairs and lack of confidence in our own government has resulted in a most unusual situation in industry. Higher prices resulting from increased cost of material, higher labor rates and excessive taxation have reacted on purchasing power and buying has slumped as a result.

The year 1937 closed with steel mill back logs exhausted and new orders coming in very slowly. During the year, however, the steel industry experienced a period of unusual development. The total horsepower installed on main roll drive motors went over 250,000 and on only two previous occasions has this total been exceeded. This together with the fact that crane builders reported the sale of more than 250 cranes to the steel industry during the year is indicative of this activity.

Never before has there been such a response to the request for information covering new developments. In compiling this report from over 80 replies received a sincere effort was made to include some information from each report. Space available, however, made it impossible to do this in every case.

TURBO DRIVEN BLOWERS

In 1930 a certain coke oven plant purchased two turbine driven blowers to handle 18,500 cubic feet of gas per minute at 100°F. The casings were designed for three stages, but, for the pressure of 1.435 pounds per square inch then required, only one wheel was installed in each. A third unit, which is a duplicate of the others, except that two wheels were installed for the same capacity against 2.7 pounds per square inch, has recently been furnished. At the same time additional wheels were ordered for converting the older units to two stages so that they could work against the higher gas pressure.

The turbines driving the first two units received steam at 125 pound gage and exhausted to the process against 10 pound back pressure. By designing this new turbine for the third blower to take steam at 450 pounds, with 100° F. superheat, and to exhaust to the two lower pressure units, the additional power is obtained at practically no additional cost for fuel.

HOT METAL TRANSFER CAR

A new type of self dumping hot metal transfer car should be listed among the year's new developments in the steel industry.

These cars are used for transporting large tonnages of molten iron from the blast furnace to the open hearth mixer or to the pig machine. Cars of this type, having a capacity of one hundred and twenty five long tons of molten iron, have recently been purchased.

The vessel which carries the molten metal or the ladle proper is of the conventional closed mixer type with single central spout opening. It is of welded construction throughout, having cast steel heads and pouring spout and a rolled steel shell. The mounting of this ladle on its transporting car trucks embodies several unique and improved features which make the development under consideration worthy of note.

The new development embodies trunnions which are relatively short and spherical in form at their extremities. These trunnions are supported in pedestals having concave spherical bearing surfaces forming in cooperation with the spherically terminated trunnions, ball joint supports. Contrary to the previous method of suspension no effort is made to keep the pedestal supports axially in alignment with the ladle itself.

The mechanism for rotating the ladle to discharge its molten metal is also mounted directly on the truck at one end of the car.

A suitable electric motor transmits rotary motion to the ladle proper through a unique and simple device which permits free swiveling of the truck and ladle with respect to each other at all times. This device permits simultaneous angular and parallel misalignment without disturbance to the mechanical connection between the driving and driven elements of the car and without binding or cramping action between the elements, either while rotating in any position or, while in transit.

The one hundred and twenty-five ton capacity cars are mounted on two eight wheel trucks and, when carrying a charge of molten metal twenty per cent in excess of rated capacity, due to wear in the refractory lining, they weigh, together with the charge, approximately 529,000 pounds.

STEEL INDUSTRY

During 1937

By W. H. BURR
Chairman A. I. & S. E. Developments Committee and Electrical Superintendent
LUKENS STEEL CO., COATESVILLE, PA.

METERING, REGULATING AND MIXING DEVICES

One of the new additions to metering and impulse systems is the metering device for fuel oil. This oil metering device is based on the use of a positive displacement meter, the speed of which is transformed into an air pressure. The shaft of the positive displacement meter rotates a flyball governor and the force transmitted by this governor against the jet pipe is proportional to the speed of the meter. The air impulse created by the transometer may be of the same magnitude as the differential pressure obtained from an orifice in a fuel gas line so that the same combustion regulator could be used for fuel oil as well as for gas. This method of oil metering has been successful in various installations made in the steel industry during the past year.

On furnaces fired with two or more fuels a number of successful combustion control installations have been made. The individual fuel flows are summarized and for each fuel flow a small air flow, which is proportional to the flow of the respective fuel, is created. The various summarizing air flows are measured by means of a common orifice and the differential pressure across this orifice represents the amount of combustion air required to burn all fuels and is used as loading impulse for the combustion regulator.

A great number of gas mixing stations were built during the past year, either for maintaining a straight volumetric proportion between two gases, or in addition with automatic correction of the volumetric proportioning in accordance with the heat value of the mixed gas, or by automatically changing the heat value of the mixed gas, in accordance with the gravity. In the latter case the flow of the mixed gas if measured through an orifice plate creates a differential pressure, which is a measurement of the heat passing through the orifice.

ELECTRIC FLOW METER

This instrument measures the flow of steam, gases and non-viscuous liquids through a closed pipe line at a given point and transmits a record of the measured value to some other point in the mill or to a distant point outside, from which supervisory control is maintained.

It consists of two instruments—a transmitter, where the differential pressure across a constriction in the line is measured, and a receiver, where the rate of flow is recorded on a chart or indicated on a scale. The system operates on the principle of telemetering instrument readings by the electrical impulse method, using one pair of conductors. A specially designed cam extracts the square root of the differential pressure across the constriction in the line (an orifice plate or ventiri tube), so that the record or indication at the receiver is on an even scale. This same cam also provides the means of telemetering the readings from the point of measurement to the receiver. An electric integrator, a new device recently developed totalizes the flow at the receiver and indicates the value on a counter index.

Another electrically-operated flow meter has been developed. A number of distinct advantages characterize this meter. The transmitter places only a negligible retarding force on the measuring device. The torque developed to operate the receiving element is very large and does not send any reaction back to the transmitter. No adjustments of the meter are necessary at the transmitting end. Several receivers may be operated from one transmitter.

Calibration of the transmitting system is simple and permanent. Two scales, one on the transmitter and the other on the receiver, make it possible to test the transmitting system without calibrating the flow measuring element and conversely, to calibrate the flow measuring element without using the electrical system.

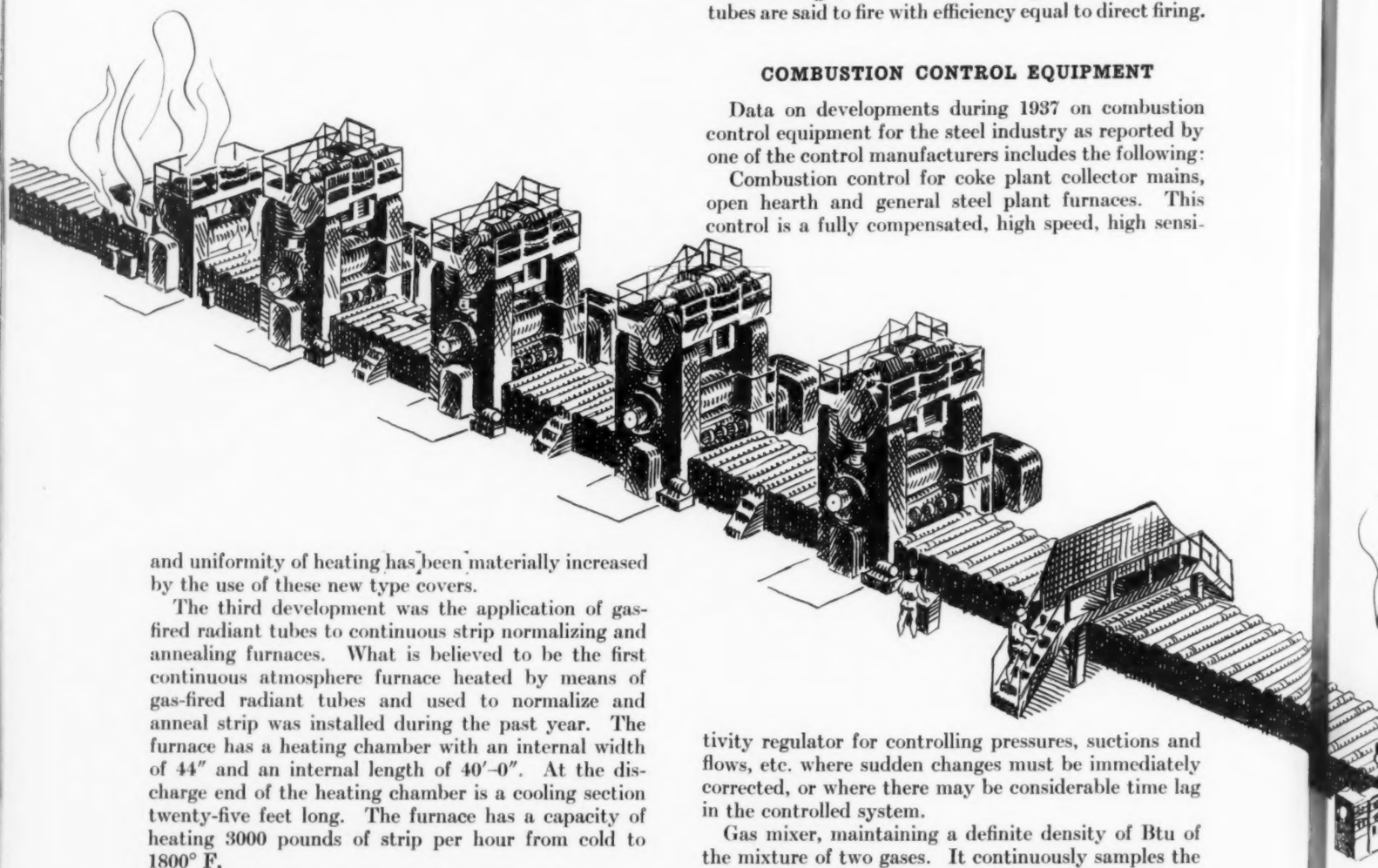
COMBUSTION

In considering combustion developments for the steel industry during the past year, four installations are outstanding and promise to have a marked influence on the steel industry in the coming year.

First is the use of straight blast furnace gas for heating soaking pits. Blast furnace gas is nearly always abundant at steel mills but due to its low Btu content and slow rate of burning, its applications have in the past been rather limited. This difficulty was somewhat overcome by mixing straight blast furnace gas with other gases of higher Btu content. The resulting mixture while capable of heating steel faster than straight blast furnace gas was still not as fast as other common gas fuels. During the past year there was installed a one-way-fired soaking pit heated entirely with straight

blast furnace gas. It is reported that heating in this pit is accomplished just as fast as in other pits using coke-oven gas, commonly recognized as the fastest heating gas.

The second development was the application recirculating fans to multiple stack annealing covers for sheet in coils. Gas-fired radiant tube annealing covers have relied chiefly on radiation and the small amount of natural convection for transferring the heat from the hot tubes to the work heated. Each stack of work is equipped with its own base, recirculating fan, inner cover and atmosphere gas inlets and outlets. The rate



and uniformity of heating has been materially increased by the use of these new type covers.

The third development was the application of gas-fired radiant tubes to continuous strip normalizing and annealing furnaces. What is believed to be the first continuous atmosphere furnace heated by means of gas-fired radiant tubes and used to normalize and anneal strip was installed during the past year. The furnace has a heating chamber with an internal width of 44″ and an internal length of 40′–0″. At the discharge end of the heating chamber is a cooling section twenty-five feet long. The furnace has a capacity of heating 3000 pounds of strip per hour from cold to 1800° F.

The fourth development was in the field of convection heating. Convection heating for temperatures as high as 1300° F. has become popular with parts manufacturers and fabricators. What is believed to be the largest convection furnace in existence was placed in operation in 1937 for heat treating oil well casings. When heating the 13⅜″ tubes to a temperature of 1200° F. and operating on a 15 minute soak, the furnace has a capacity of 70,000 pounds per hour. Heating is accomplished by means of six low pressure air heaters operating on coke oven gas.

Another interesting combustion contribution is a new gas fired recuperative type radiant tube which was developed for use in fuel fired furnaces for various annealing, normalizing and heat treating operations in steel mill practice. This new tube embodies the recuperative principle, and is said to be an entirely new principle in radiant tube design. It utilizes waste gases to preheat the incoming combustion air before it enters the combustion chamber, thus requiring less fuel and making it the most economically operated radiant tube yet developed. By admitting the necessary combustion air throughout the entire length of the burning chamber, a positive mixture of air and gas is provided just where it is needed for perfect combustion which results in an even temperature over the entire length of the tube, thus making it possible to maintain uniform temperature throughout the entire heating chamber. These tubes are said to fire with efficiency equal to direct firing.

COMBUSTION CONTROL EQUIPMENT

Data on developments during 1937 on combustion control equipment for the steel industry as reported by one of the control manufacturers includes the following:

Combustion control for coke plant collector mains, open hearth and general steel plant furnaces. This control is a fully compensated, high speed, high sensitivity regulator for controlling pressures, suctions and flows, etc. where sudden changes must be immediately corrected, or where there may be considerable time lag in the controlled system.

Gas mixer, maintaining a definite density of Btu of the mixture of two gases. It continuously samples the mixture and adds make-up gas to maintain a definite, adjustable specific gravity of the mixture. If the two component gases are slightly different in inherent density, the control will regulate the mixture to a definite Btu.

Combustion control for oil fired furnace which accurately measures the oil by a motor driven, meter type pump, and continuously proportions the combustion air to the oil. It is independent of the viscosity or temperature of the oil, errors from these sources being eliminated.

Ratio Control, gasometer type. This control measures, to a high degree of accuracy, the flow of air and gas for combustion purposes, or of two gases for gas mixing on a volumetric basis. It is of the gasometer

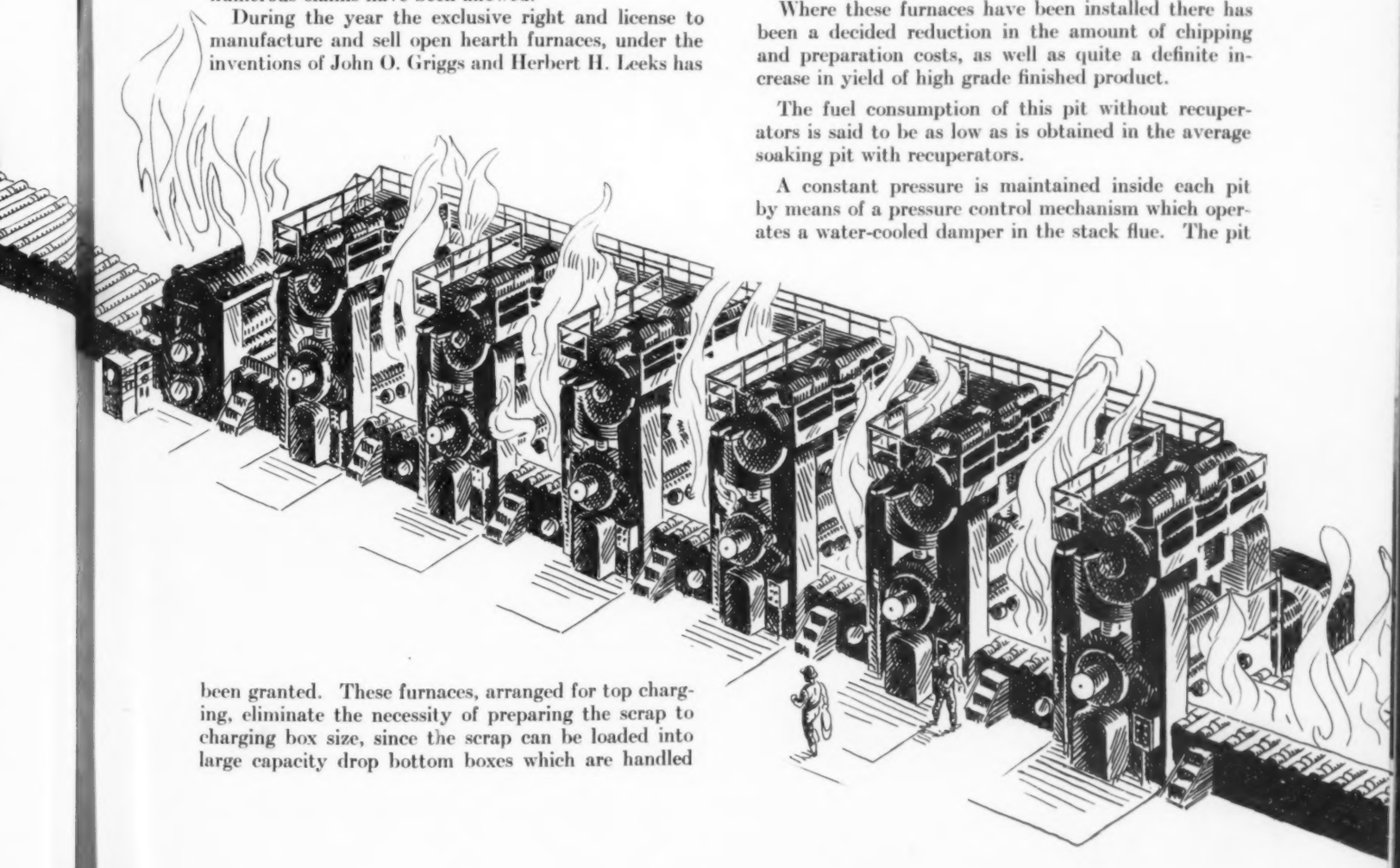
type, highly sensitive and rapid in operation. The adjustment of the ratio may be remotely set from the manual station.

Combustion control for mixed gases which measures the flow of any number of gases, automatically adjusting the total air for the mixture of gases, whatever the proportions and individual Btu of the mixed gases may be.

OPEN HEARTH FURNACES

During the year 1937, there has been developed a new process or method which will permit of a large part, if not all, of the entire charge of cold metal required for a melting heat, to be deposited in the furnace at one time, thereby effecting a more economical method as to power and fuel consumption, speed of operation, as well as maintenance cost of the charging equipment and furnace. Briefly, it consists of a furnace construction having a removable furnace front permitting the use of a novel charging machine which employs a container of ample size to hold the entire charge. The container or pan is adapted to be filled with its cold metal charge at any convenient point. The pan has a flexible rolling bottom substantially equal in area to the furnace hearth area to be charged, the discharge of the cold metal from the pan being such that the layer on the hearth will be approximately the thickness and area of the layer on the pan. The novel features of the furnace construction and the charging machine are the subject matter of pending patents for which numerous claims have been allowed.

During the year the exclusive right and license to manufacture and sell open hearth furnaces, under the inventions of John O. Griggs and Herbert H. Leeks has been granted. These furnaces, arranged for top charging, eliminate the necessity of preparing the scrap to charging box size, since the scrap can be loaded into large capacity drop bottom boxes which are handled by the hot metal crane and lowered into the furnace to a point near the furnace bottom before opening and depositing the charge.



SOAKING PITS AND HEATING FURNACES

The trend in steel mills at the present time is toward the manufacturing of steel of more exacting specifications, such as high carbon steels, in greater tonnages, which has created a demand for better quality and uniformity of heating in soaking pits.

The absence of any accurate control, other than a skilled heater, in soaking pit practice has prompted the design of ingot heating equipment which employs modern apparatus for automatically controlling atmosphere and temperature throughout the heating cycle, and at the same time provides a graphic record of furnace performance.

A circular, ingot heating furnace has been developed to provide the same accurate control and uniform day-after-day operation that has been found absolutely necessary in the heat treating of steel products in the finishing department.

This furnace does not fire large quantities of flame from one source. Instead, the heat is applied through multiple burners firing tangentially around the periphery of the furnace, which together with automatic accurate valves and premixers, provides the exact distribution of proper air-gas ratios to carry suitable atmospheres at all rates of firing.

Where these furnaces have been installed there has been a decided reduction in the amount of chipping and preparation costs, as well as quite a definite increase in yield of high grade finished product.

The fuel consumption of this pit without recuperators is said to be as low as is obtained in the average soaking pit with recuperators.

A constant pressure is maintained inside each pit by means of a pressure control mechanism which operates a water-cooled damper in the stack flue. The pit

pressure may be changed, as desired, at the pressure control instrument.

The furnace cover is dome-shaped and the edges rest in a deep cast iron sand seal which encircles the pit. This method of sealing the pit opening assures that there will be no escape of hot gases and has proven very satisfactory.

This furnace has given the steel industry a soaking pit with the same accurate control and operating flexibility that is provided for furnaces in the heat-treating and finishing departments.

The alloy steel maker, after having endeavored to use pusher type furnaces for heating small ingots and billets prior to rolling, has in some cases given up the continuous furnace and resorted to batch type, hearth furnaces using the in and out method of charging and drawing.

A new type of rotary furnace has been built, which avoids the difficulties of the conventional, sand-sealed rotary furnace for the heating of ingots and billets.

The first of these units was installed at a plant in Canada for heating approximately six tons per hour of high grade steel, such as hollow drill, high speed billets and other tool steels common to their manufacture.

The hearth is caused to rotate from the charging door to the discharge door and a particular feature of the furnace is that it is made almost entirely of light weight refractories.

The furnace may be operated either as a continuous furnace or a batch type furnace, and when operated as a batch type furnace, has the advantage of keeping the steel moving away from under burners, so that no steel stands in front of a burner long enough to become over-heated.

The fact that the furnace is self-emptying, is highly desirable. Toward the end of a turn the operators cease to charge steel into the furnace and by the time the mill stops, the furnace is empty.

Due to the circular shape of the furnace and the small size of the doors as compared with those of the hearth type furnaces, the pressure, and therefore, the temperature in this furnace, is easily controlled.

The furnace would appear to offer an entirely new and modern method of heating ingots for the smaller mills where soaking pits are out of the question. It is said to provide a more nearly ideal equipment for the continuous heating of billets than has ever before been offered to the steel industry.

A forging heater is now on the market, equipped with electric eyes, for controlling temperature, for use on materials varying from $\frac{1}{8}''$ in diameter to $2\frac{1}{2}''$; and on these heaters any length heat for upset work or drop forge work, that varies from 1 to 24″, can be obtained on the end of the bar or at any point on any length bar.

A six-foot bar heater has also been perfected, which will heat any size bar from $\frac{3}{8}''$ up to 1″ diameter, 72″ long. The advantage of such a heater is that every Btu in the Kwh goes into the piece of steel. The only lost Btu's are those that are radiated. Therefore, the more quickly a bar of steel can be heated, the lower is the electrical consumption.

Sucker rods consist essentially of long rods which are arranged to be connected end to end and form a continuous rod which reaches from the walking beam at ground level down to the oil pool at the bottom of the oil well.

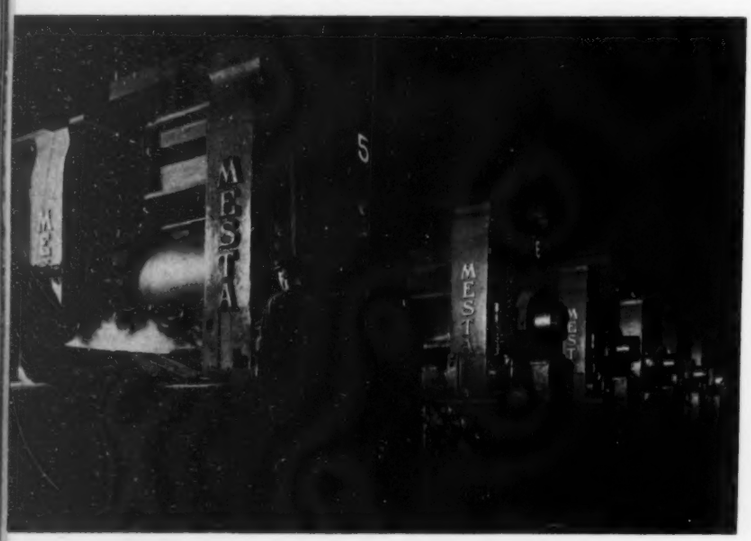
A recently drilled well in a Texas oil field passed the 10,000-foot mark. A steel rod of uniform diameter 10,000 feet long will develop a stress in the section nearest the top of approximately 35,000 pounds per square inch. When we add to this stress the weight of a column of oil 10,000 feet long, we begin to see the problems confronting the sucker rod manufacturers as petroleum wells went deeper and deeper into the earth.

To make this possible, one of the engineering companies designed a chain conveyor type furnace with upstanding fingers on the chain links. Between each set of chains there was provided a high pier with an alloy pier cap. A sucker rod laid across the furnace chamber rested on the stationary piers as well as on the chains. As a result, when the chains moved forward, the upstanding fingers caused the rods to roll.

Rolling the rods through the furnace accomplished exactly what the engineers had attempted to do. It provided a means for delivering sucker rods directly from a furnace normalized and absolutely straight.

Because of the many advantages and special features incorporated in this furnace, there is no question but that it should be classed as one of the outstanding developments for the steel industry.

View of Jones & Laughlin Steel Corporation new continuous hot and cold strip mill.



RECUPERATORS

A manufacturer of abrasive and refractory materials reports several additional reheating continuous furnaces are being installed. The new designs incorporates details which make it possible to clean the spaces between tubes while the furnace is in operation. The carry-over, scale principally, is quite pronounced where the furnace is operated at high rating and it will be a distinct advantage in instances of this kind if the scale can be removed while the furnace is in operation thus permitting all of the heating surface of the tubes to be exposed continuously to the action of the waste gases.

A recuperator has been applied to a soaking pit furnace for the preheating of straight blast furnace gas which, when burned with preheated air for combustion, has proved highly satisfactory to the operators. This is to be the first application of any recuperator for the preheating of this low Btu gas on soaking pits.

Similar recuperators have also been applied to small capacity steel melting furnaces for making special steels with highly satisfactory results to the operators. The life of the tubes in this service is exceptionally good. It has been possible to operate the furnace with waste gas temperatures entering the recuperator at 2800° for a period equivalent to about two and one-half years without the necessity of replacing a tube.

ROLLING MILLS

During the year 1937, like in the previous several years, the new construction in steel mills was centered around strip mills. Several large hot strip mills were put in service or were under construction. The maximum width of mills has been increased to ninety-eight inches. The delivery speed has been stepped up to 2150 feet per minute. The total capacity of main drives on a single hot mill has reached a value of over 42,000 horsepower. The capacity of a single drive has been increased from 4500 horsepower to 5000 horsepower.

The speed of cold rolling of strip has been stepped in several instances up to about 1750 feet per minute, with a 2000 feet minute goal being within sight. This requires, of course, greatly increased power and a still greater precision of control, particularly while accelerating or retarding the mill while rolling. The electrical tensiometers for indicating and controlling strip tension between stands are finding a wider use.

A very interesting and novel rod mill has been built and electrified. It is arranged to finish simultaneously four strands of rods, at a speed close to 4000 feet per minute. A total of nine direct current motors are employed for driving this mill, with a very special type of control.

In the tin plate or lighter gage industries the production of light gauge strip in reversing or continuous cold mills has been the major development of the last few years.

Studies have been made of the possibility of a low cost type of unit to take care of the modified tonnages required by independent companies. The reversing hot strip mill in combination with cold reduction mills and skin pass mills has been the possible answer to this problem.

A two-high reversing hot strip mill, equipped with a vertical edging mill and reheating furnace on either sides of the mill furnished with reelers, and a hot coiler at the end of the bed has been installed. It has a capacity of 7500 tons per month, maximum width 17½″, a minimum gauge 0.125″. The builders point that this mill has a wide field of utility, in large steel plants by increasing the flexibility of the output, in small plants by the addition of a popular line of production.

During the last year the picture has been changing and the present indication is that during the next several years, the other products of the steel plants will be given serious thought and consideration.

Modern developments of antifriction bearings for rod and merchant mills along with other developments in companion machinery construction will naturally bear fruit and several such mills are planned.

This is also true of the seamless tube industry, structural, rail, blooming, and allied mills.

In new equipment for main roll drives, probably the most unusual is the reversing slabbing mill drive in the Pittsburgh district. This drive consists of a 10,000 horsepower twin-motor for the main rolls and a 3000 horsepower motor for the edger. This installation will differ from previous installations in that the edging roll motor is larger than has been used before, the twin-motor drive will consist of two single armature motors instead of two double armature machines as previously used and the mill will have two complete pulpits so that it can be operated either as a slabbing mill or a blooming mill. On pages 54 to 58 will be found the complete statistics relating to the application of electric motors to main roll drives which were installed during 1937.

In addition to the mill development over these past few years, there has been a great development in the steel industry of processing and handling equipment such as continuous pickling lines, rotary coil picklers, electrolytic cleaning lines, continuous shearing lines and now we are in the development stage of electrolytic coating in strip form, and this development promises most activity in the next two years.

A large number of processing uncoilers are in operation which make it possible to uncoil hot rolled strip steel at high rates of speed without coil breaks. The various steel companies were quick to take advantage of the product free of objectionable marks and the material so processed was also usuable for many articles without other processing operations.

Continuous strip pickling lines have been developed and installed during the year permitting a high rate of speed and exhausting systems so applied as to maintain the departments entirely free of acid fumes.

General view of one of the new continuous rod mills of the American Steel & Wire Company.

BEARINGS

Oil Sleeve Type

There has been a noticeable increase in the use of the oil sleeve bearings on roll necks during the past year. Bearings having a capacity of 4,050,000 pounds each have been installed on a number of backing-up rolls.

A new precision oil film bearing represents a radical departure from conventional bearing design being essentially a self contained oil film bearing. In construction, this bearing consists of a hardened and precisely ground alloy steel hub mounted on the shaft and a diamond bored babitt lined steel sleeve fixed in the housing, sliding motion taking place between the outside surface of the hub and the inner surface of the sleeve. The hub design embodies two essential features. First, the hub acts like the impeller of a centrifugal pump delivering the lubricating oil which is maintained at such a level in the bearing housing as to immerse the lower portion of the hub, to the bearing surface under pressure and in quantities more than adequate for lubrication alone, the excess serving to cool the bearing.

As the second and relatively more important feature, the bearing surface of the hub consists of a flexible rim and by virtue of a slight elastic deflection, a wedge-like oil film is formed with sufficient pressure to "float" the load in accordance with the hydrodynamic principle of lubrication. Thus wear is eliminated and friction reduced to a minimum.

Ball Bearings

Designed especially to meet advance engineering requirements, a new cartridge self-sealed bearing has been marketed which has the following advantages. It has at least 100 per cent more grease capacity than any other standard self-sealed bearing, and employs an entirely new labyrinth seal which is equally efficient in a horizontal or vertical position. The flanged metal seal is removable to facilitate inspection, cleaning or re-greasing of the bearing and seals permanently maintain their efficiency without wear, friction, or power loss.

In utilizing the built-in, grease-refilling plug, no parts are exposed to the dirt hazard in preliminary handling. Double-row width safeguards against cocking and prevents slippage and "peening" in housing or on the shaft. Locknuts are no longer needed. Overall length of mounting is shortened and the shaft overhang is reduced. Reduction in cost through simplified design, elimination of protective closure parts, and speeding up assembly are their very desirable features.

Non-Metallic Type

Among the new bearing applications is the adapter type of non-metallic moulded bearings. They are provided with a bronze body structure which permits the immediate replacement of the conventional metallic type of bearing without replacing or machining the chucks. Their coefficient of friction is the lowest of any known substance applicable to this type of duty, thereby making an appreciable saving in power. As to hardness they range from eighty-five to ninety-five scleroscope.

Acid resisting non-metallic bearings represent another important contribution to the steel industry. These bearings are adapted to both the roll and bearing proper on pickling operations. A pyrex glass sleeve is fitted over the stub shaft of the roll and this in turn is fitted with an acid resisting non-metallic bushing. These bearings or bushings have been in service approximately one year and nine months. They are in excellent condition showing no appreciable wear or deterioration. The rolls on this job were also made of non-metallic material. They were built up of a series of discs and longitudinal slats. After eleven months service the only wear that occurred was on the slats due to the abrasive action of the scale on the strip being cleaned. The slats can be replaced and the rolls again returned to service.

LUBRICATION SYSTEMS

It is a fact that centralized lubricating systems have been used to a greater extent during 1937 than at any time in the past and these devices offer one of the most outstanding opportunities for economy of any small investment in plant equipment. They have been refined and improved and their application boradened to include practically all types of equipment found in the average steel plant.

Every one of the new continuous hot strip mills, as well as cold mills, installed have been equipped with automatic centralized grease lubricating systems. Whereas in the past the automatic grease systems were generally applied to the lubrication of roll neck bearings only, they have subsequently been extended to include the table roll bearings as it has been found that these bearings when lubricated by hand often are responsible for mill delays and therefore, the centralized system of lubrication is a worth while economy for what in the past has been considered as more or less minor or unimportant bearings.

In the past much effort has been put into the development of motor driven grease pumps, striving to get the pumping unit simpler, more rugged, and capable of handling heavy greases which are contaminated with air pockets. Believing that a pump for handling heavy greases should have very slow moving parts and exceptionally large grease cylinders one manufacturer has developed a new hydraulic, pneumatic operated pump.

This pump is designed with a hydraulic, or air cylinder, placed between two grease cylinders. The entire piston assembly is in reality a double ended piston working in two opposite grease cylinders and functioning as a two cylinder pump. The hydraulic fluid, or compressed air, is diverted first to one side and then to the other side of the hydraulic piston causing movement of the entire piston assemblies accordingly. The design incorporates a follower piston in the reservoir allowing for hydraulic or air pressure above this follower assembly to force the grease into the pump cylinders. Lubrication of the average circuit can thus be accomplished with from one to five strokes of the pump pistons, as compared to several hundred strokes with the conventional type of motor driven pumping unit. This unit is designed to develop sufficient grease pressures for lubrication of the circuits by using hydraulic, or air pressure, at a maximum of 100 pounds per square inch.

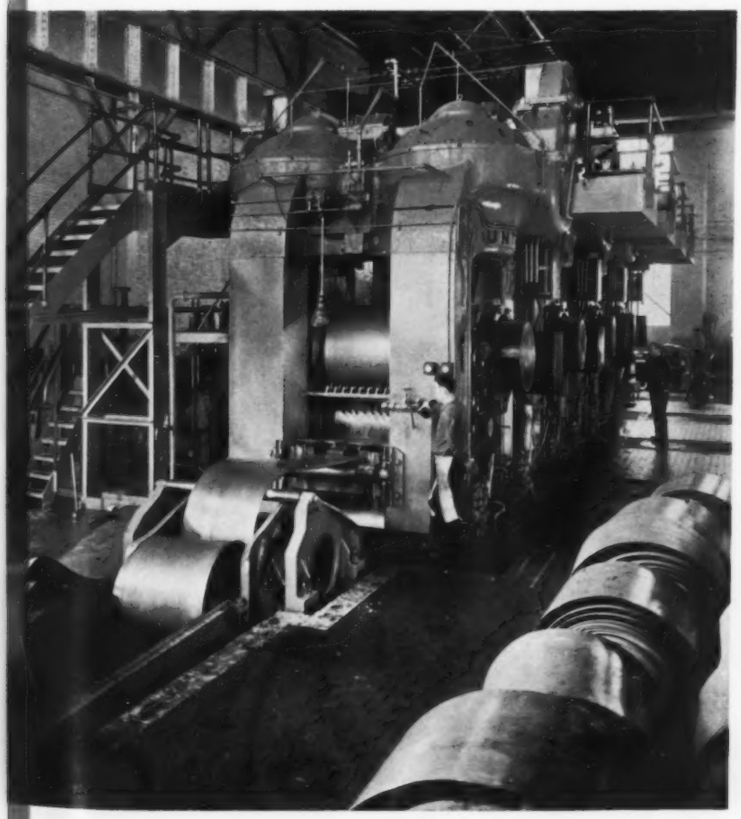
LUBRICANTS

Particular attention has been paid to still further improving on lubricants for electrical equipment, including overhead travelling cranes, both antifriction and plain bearing types. Not only was the lubrication of the bearings themselves given serious consideration, but also attention was given to the elimination of extensive losses due to oil-soaked windings on motors and generators, as was the damage to products caused by the dripping or throwing off of oils and greases.

Improvements have recently been effected in grease type grades of oil, which make these an ideal general purpose lubricant for ball, roller or plain bearings on motors, fans, blowers, ingot cars, cranes, etc. These lubricants while soft enough to be applied by means of hand operated pressure guns or grease systems, will lubricate equally well over a very wide range of operating conditions, including high temperatures encountered on a great many applications throughout the steel mills. Recent improvements effected also enable these same grades to lubricate satisfactorily under the very heaviest loads. Tests have shown a fifty per cent increase in load carrying capacity, as well as less friction loss.

These improvements were brought about without the use of lead soaps, sulphur or acids, such as heretofore used and so do not have any of the usual objectionable features.

Entry end of new four-high tin plate mill, Republic Steel Corp., Niles, Ohio.



ROLLS

A valuable contribution to the industry during this year is an improvement of cold rolling mill rolls. After several years of development and experimental work one manufacturer is producing hardened and ground rolls for cold rolling work, made from homogeneous, alloy steel. Special heat treating equipment to handle this product has been provided and at present they are in a position to produce rolls with a maximum size of about 20″ body diameter by 60″ length of body or working face, with overall length not exceeding about 125″. Scleroscope hardness on the working face will run about 100 and about 40 to 50 on the necks.

From another manufacturer comes a report covering composite cast rolls having outer working faces with hardness variable from 70 to 100 scleroscope. The central body portions and the necks and wabblers are machinable grey iron. Their use is for flat rolling on two-high hot strip mills, and as work rolls for both four-high hot and cold mills.

SHEARING

During the past year, there has been developed automatic shearing equipment to operate accurately at very high rates of speed, whereas heretofore when accuracy was required, shearing speeds of not over 200 feet per minute were the maximum obtainable. Now speeds of 400 to 500 feet per minute are possible with absolute accuracy as to cuts.

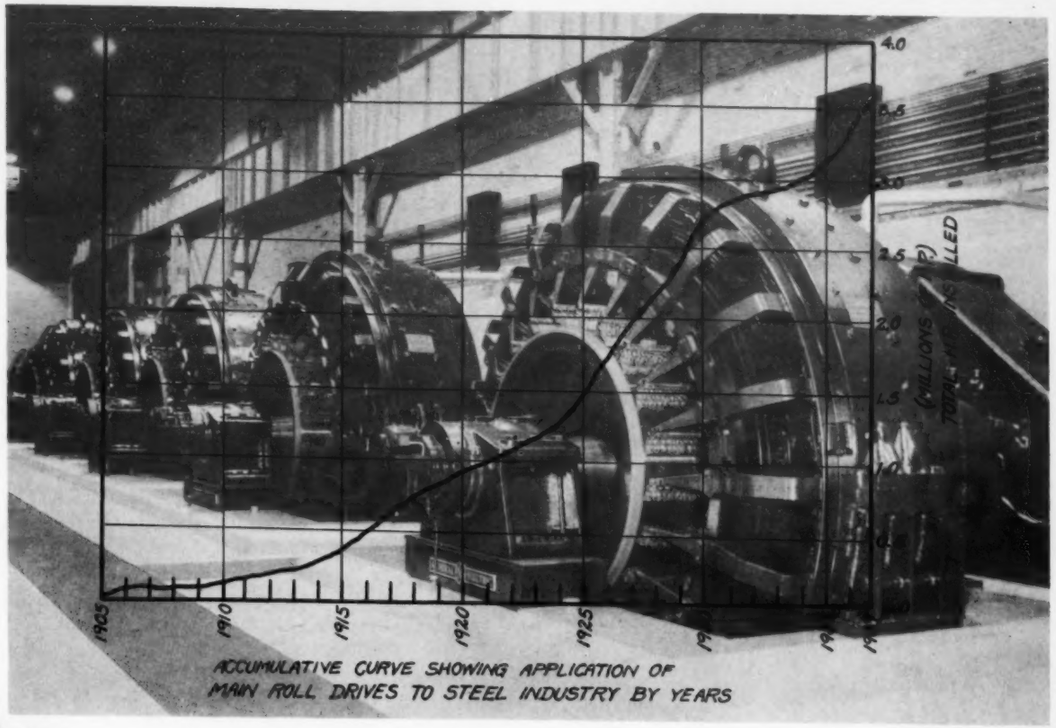
A bloom and slab shear is now available. This avoids the drawbacks of both the downcut and upcut shear and has a combination of down and up motion of the knives. The shear proper consists of a bottom knife block, a top knife block, a crankshaft centered in the bottom knife block, a pin in the top block and two interconnecting links which absorb all the shearing stresses. A simple frame takes up the external movement. Power is transmitted to the crank shaft from an independently mounted gear drive through a universal spindle.

In operation, the top knife block first descends on the material to be cut and forming thereby a simple gag, then completing the stroke, the bottom block, so to speak, pulls itself up by its own boot straps. The actual cutting stroke is limited to the thickness of the material which is to be cut, plus the small overlap of the knives.

Another manufacturer reports they have developed during the current year a new squaring shear. In this shear they have eliminated the jaw clutch that ordinarily functions on one end of the crank shaft. They incorporated what is called twin drive which drives the crank shaft from both ends, and instead of a jaw clutch, they have developed a friction clutch which is mounted back on an auxiliary shaft, thereby eliminating practically all clutch trouble on this type of shear.

They have also developed a guillotine type resquaring unit to be used in the finishing departments of strip mills which is, in principle, about like the resquaring units that have been built, only they are equipped with bakelite slats, etc., to prevent the scratching of sheets. The production on these shears is exceedingly high.

1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925



ACCUMULATIVE CURVE SHOWING APPLICATION OF
MAIN ROLL DRIVES TO STEEL INDUSTRY BY YEARS

1925

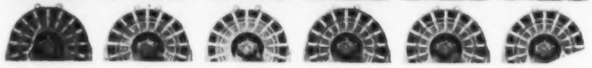
1926

1927

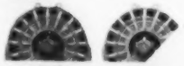
1928

1929

1930

1931 

1932

1933 

1934

1935

1936

1937

Pictogram showing installation of Electric Motors over 300 Horsepower Applied to Main Roll Drives in the Iron and Steel and Allied Industries from 1905 to 1937 inclusive.

Scale: Represents 20,000 H. P.

ELECTRIC MOTORS OVER 300 HORSE POWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING THE YEAR 1937

No.	H.P.	Speed	Voltage	Freq.	Type of Mill	Purchaser	Location	Manufacturer
1	300	250/750	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
2	300	300/900	230	DC	Rotary Trimming Shear 100″ Plate Mill	Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	Crocker-Wheeler
3	300	300/1200	600	DC	Reel for 72″ Cold Mill	Otis Steel Company	Cleveland, O.	General Electric
4	300	300/1200	600	DC	Reel for Tandem Cold Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
5	300	400/800	230	DC	14″ Cold Brass Mill	Revere Copper and Brass Company	Rome, New York	General Electric
6	300	500	440	25	44″ Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
7	300	500	440	25	44″ Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
8	300	514	440	60	54″ Hot Strip Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Westinghouse
9	300	514	440	60	54″ Hot Strip Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Westinghouse
10	300	514	2200	60	Hot Slab Squeezer	Carnegie-Illinois Steel Corporation	Gary, Indiana	Crocker-Wheeler
11	350	215/430	250	DC	42″ Cold Strip Mill	Youngstown Sheet & Tube Company	Indiana Harbor, Indiana	Westinghouse
12	350	215/430	250	DC	42″ Cold Strip Mill	Youngstown Sheet & Tube Company	Indiana Harbor, Indiana	Westinghouse
13	350	215/430	250	DC	42″ Cold Strip Mill	Youngstown Sheet & Tube Company	Indiana Harbor, Indiana	Westinghouse
14	350	440	2200-3 ph.	60	Edger Drive	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
15	350	500/1250	250	DC	42″ Temper Pass Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
16	350	500/1250	250	DC	42″ Temper Pass Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
17	350	500/1250	250	DC	42″ Temper Pass Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
18	350	500/1250	250	DC	42″ Temper Pass Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
19	350	500/1250	250	DC	42″ Temper Pass Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
20	350	500/1250	250	DC	42″ Temper Pass Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
21	400	200/400	600	DC	Rail Rerolling Mill	Missouri Rolling Mill Company	St. Louis, Missouri	General Electric
22	400	300/900	250	DC	16″ x 38″ Tandem Cold Mill	Greer Steel Company	Anderson, Indiana	General Electric
23	400	400/1150	250	DC	Single Stand Cold Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	General Electric
24	400	400/1150	250	DC	Single Stand Cold Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	General Electric
25	400	800	440	60	Brass Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	Westinghouse
26	500	150/450	600	DC	48″ Hot Strip Mill	Tennessee Coal, Iron and R. R. Co.	Fairfield, Alabama	General Electric
27	500	150/600	600	DC	80″ Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
28	500	150/600	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
29	500	150/600	600	DC	44″ Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
30	500	250/750	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
31	500	250/875	600	DC	42″ Reversing Cold Roll Mill	Mitsui	Japan	General Electric
32	500	250/875	600	DC	42″ Reversing Cold Roll Mill	Mitsui	Japan	General Electric
33	500	500	230	DC	Slab Reducer	Republic Steel Co.	Cleveland, O.	Westinghouse
34	500	600/800	600	DC	42″ Tandem Cold Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Crocker-Wheeler
35	600	400/800	250	DC	14″ Steckel Mill	International Nickel Company	Huntington, West Va.	General Electric
36	600	600/960	250	DC	10½″—26″ x 24″ Reversing Cold Mill	Thomas Steel Company	Warren, Ohio	General Electric
37	700	225/625	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
38	700	300/625	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
39	700	300/900	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
40	700	300/900	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
41	700	600	2300	60	12″ Merchant Mill	Rustless Iron & Steel Corporation	Baltimore, Maryland	Westinghouse
42	800	250/750	600	DC	84″—3-Stand Tandem Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
43	800	400/800	240	DC	Tube Mill	Timken Roller Bearing Company	Canton, Ohio	Westinghouse
44	800	400/970	600	DC	Cold Mill	Aluminum Company of America	Edgewater, New Jersey	General Electric
45	800	575/1010	250	DC	Tandem Brass Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	Westinghouse
46	800	575/1010	250	DC	Tandem Brass Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	Westinghouse
47	1000	250/750	600	DC	Tempering Pass Mill	Superior Steel Corp.	Pittsburgh, Pennsylvania	General Electric
48	1000	300/375	600	DC	Hot Copper Reversing Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	General Electric
49	1000	500/1000	600	DC	12″/14″—35″/29″ Reversing Mill	Acme Steel Company	Riverdale, Illinois	General Electric
50	1000	600/800	600	DC	42″ Tandem Cold Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Crocker-Wheeler
51	1000	600/800	600	DC	42″ Tandem Cold Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Crocker-Wheeler
52	1000	600/800	600	DC	42″ Tandem Cold Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Crocker-Wheeler
53	1250	240	6600-3 ph.	60	80″ Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
54	1250	200/240	600	60	Merchant Bar Mill	Steel Co. of Canada	Montreal, Quebec	General Electric
55	1250	250/612	600	DC	72″ Cold Mill	Otis Steel Company	Cleveland, O.	General Electric
56	1250	400/800	600	DC	72″ Tandem Cold Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
57	1250	400/800	600	DC	72″ Tandem Cold Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
58	1250	400/800	600	DC	72″ Tandem Cold Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
59	1250	400/800	600	DC	54″ Tandem Cold Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
60	1250	400/830	600	DC	Cold Mill	Aluminum Company of America	Edgewater, New Jersey	General Electric
61	1250	500/750	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
62	1250	500/800	600	DC	10″—26″ x 24″ Reversing Cold Mill	McLouth Steel Company	Detroit, Mich.	General Electric

No.	H.P.	Speed	Voltage	Freq.	Type of Mill	Purchaser	Location	Manufacturer
63	1250	600	6600	60	Hot Sheet Mill	Tennessee Coal, Iron and R. R. Co.	Fairfield, Alabama	Westinghouse
64	1250	600/800	600	DC	42" Tandem Cold Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Crocker-Wheeler
65	1500	25/50	600	DC	Reversing Mill	Aluminum Company of America	Edgewater, New Jersey	General Electric
66	1500	150/450	600	DC	4-Strand Rod Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	General Electric
67	1750	210/525	600	DC	54" Cold Reversing Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
68	1750	210/525	600	DC	54" Cold Reversing Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
69	1750	400/600	600	DC	42" Reversing Cold Mill (Roll)	Mitsui	Japan	General Electric
70	1750	600	2300	60	Pipe Straightening Mill	Spang-Chalfant Co.	Economy, Penna.	General Electric
71	2000	514	2200	60	Merchant Bar Mill	Steel Company of Canada	Montreal, Quebec	General Electric
72	2250	720	6600	60	Cold Mill	Bridgeport Brass Co.	Bridgeport, Connecticut	General Electric
73	2500	150	6600	25	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
74	2500	175/350	600	DC	48" Hot Strip Mill	Tennessee Coal, Iron & R. R. Co.	Fairfield, Ala.	General Electric
75	2500	175/350	600	DC	48" Hot Strip Mill	Tennessee Coal, Iron & R. R. Co.	Fairfield, Ala.	General Electric
76	2500	175/350	600	DC	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
77	2500	225/450	600	DC	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
78	2500	225/450	600	DC	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
79	2500	225/450	600	DC	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
80	2500	225/450	600	DC	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
81	2500	225/450	600	DC	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
82	2500	225/450	600	DC	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	Allis-Chalmers
83	2500	225/450	600	DC	84" Three Stand Tandem Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
84	2500	225/450	600	DC	84" Three Stand Tandem Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
85	2500	375	6600	25	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
86	2500	375	6600	25	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
87	2500	375	6600	25	44" Hot Strip Mill	Inland Steel Company	Indiana Harbor, Indiana	General Electric
88	2500	514	6600	60	10" Rod Mill	Dominion Steel Co.	Sidney, Nova Scotia	General Electric
89	3000	60/180	700	DC	45" Universal Slabbing Mill	Carnegie-Illinois Steel Corporation	Edgar Thomson Works, Braddock, Penna.	Westinghouse
90	3000	144	6600	60	Hot Strip Mill	Bethlehem Steel Co.	Sparrows Point, Maryland	Westinghouse
91	3000	150/350	600	DC	48" Hot Strip Mill	Tennessee Coal, Iron & R. R. Company	Fairfield, Alabama	General Electric
92	3000	150/350	600	DC	48" Hot Strip Mill	Tennessee Coal, Iron & R. R. Company	Fairfield, Alabama	General Electric
93	3000	175/350	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
94	3000	200/400	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
95	3000	200/400	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
96	3000	200/400	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
97	3000	200/400	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
98	3000	200/400	600	DC	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
99	3000	200/400	550	DC	Hot Strip Mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
100	3000	200/420	600	DC	Hot Strip Mill	Wheeling Steel Corp.	Steubenville, Ohio	General Electric
101	3000	360	6600	60	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
102	3000	360	6600	60	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
103	3000	360	6600	60	Hot Strip Mill	Bethlehem Steel Company	Sparrows Point, Maryland	Westinghouse
104	3000	514	2300-3 Ph.	60	98" Hot Strip Mill	Republic Steel Corporation	Cleveland, Ohio	Allis-Chalmers
105	3000	514	2300-3 Ph.	60	98" Hot Strip Mill	Republic Steel Corporation	Cleveland, Ohio	Allis-Chalmers
106	3000	514	2300-3 Ph.	60	98" Hot Strip Mill	Republic Steel Corporation	Cleveland, Ohio	Allis-Chalmers
107	3000	514	2300-3 Ph.	60	98" Hot Strip Mill	Republic Steel Corporation	Cleveland, Ohio	Allis-Chalmers
108	3500	125/250	600	DC	48" Hot Strip Mill	Tennessee Coal, Iron & R. R. Co.	Fairfield, Alabama	General Electric
109	3500	150	6600-3 Ph.	60	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
110	3500	150/300	600	DC	54" Cold Reversing Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
111	3500	150/300	600	DC	84" Three Stand Tandem Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
112	3500	175/350	600	DC	48" Hot Strip Mill	Tennessee Coal, Iron & R. R. Co.	Fairfield, Ala.	General Electric
113	3500	175/350	600	DC	72" Hot Strip Mill	Otis Steel Company	Cleveland, Ohio	General Electric
114	3500	175/350	600	DC	72" Hot Strip Mill	Otis Steel Company	Cleveland, Ohio	General Electric
115	3500	257	6600-3 Ph.	60	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
116	3500	400	6600-3 Ph.	60	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
117	3500	400	6600-3 Ph.	60	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	Allis-Chalmers
118	4500	125/250	600	DC	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
119	4500	125/250	600	DC	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
120	5000	40/80	700	DC	Blooming Mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
121	5000	40/80	700	DC	45" Universal Slabbing Mill	Carnegie-Illinois Steel Corporation	Edgar Thomson Works, Braddock, Penna.	Westinghouse
122	5000	40/80	700	DC	45" Universal Slabbing Mill	Carnegie-Illinois Steel Corporation	Edgar Thomson Works, Braddock, Penna.	Westinghouse
123	5000	80/160	600	DC	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
124	5000	100/200	600	DC	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
125	5000	125/250	600	DC	80" Hot Strip Mill	Carnegie-Illinois Steel Corporation	Irvin, Penna.	General Electric
126	5000	360	6600	60	Tube Mill	Youngstown Sheet & Tube Company	Youngstown, O.	Westinghouse
127	5000	360	6600	60	Tube Mill	Youngstown Sheet & Tube Company	Youngstown, O.	Westinghouse
128	7000	40/100	700	DC	46" Blooming Mill	Great Lakes Steel Corp.	Ecorse, Mich.	Westinghouse
129	7000	50/100	700	DC	45" Blooming Mill	Tennessee Coal, Iron & R. R. Co.	Fairfield, Ala.	Westinghouse
129	231,950							

STATISTICS AND ANALYSIS OF ELECTRIC MOTORS OVER THREE HUNDRED HP

SOLD FOR MAIN ROLL DRIVE SERVICE IN THE IRON AND STEEL INDUSTRY IN 1937

APPLICATION OF MOTORS TO VARIOUS TYPES OF MILLS

Type of Mill	Number	Total Motors	Total Horsepower
Hot Strip and Sheet	14	57	145,350
Cold Mills	15	32	37,800
Brass Mills	4	4	2,300
Rod Mills	2	9	8,850
Plate Mills	1	1	300
Temper Pass Mills	2	7	3,100
Rail Rerolling Mills	1	1	400
14″ Steckel Mill	1	1	600
Merchant Mill	2	3	3,950
Aluminum Cold Mill	1	1	1,250
Hot Copper Reversing Mill	1	1	1,000
Reversing Mills	2	2	2,500
Tube Mills	2	3	10,800
Pipe Straightening Mill	1	1	1,750
Slab and Blooming Mills	4	6	32,000
	51	129	251,950

ANALYSIS OF MOTORS PURCHASED AND THEIR APPLICATION

Company	Location	Type of Mill	Total Motors	Total Horsepower
Acme Steel Company	Riverdale, Ill.	Reversing Mill	1	1,000
Aluminum Company of America	Edgewater, N. J.	Cold Mill	2	2,050
		Reversing Mill	1	1,500
American Rolling Mill Co.	Middletown, Ohio	Blooming Mill	1	5,000
Bethlehem Steel Company	Sparrows Point, Md.	42″ Tandem Cold Mill	6	6,000
		4 Strand Rod Mill	8	6,350
		Hot Strip Mill	10	30,000
		54″ Hot Strip Mill	2	600
		Hot Strip Mill	1	500
Bridgeport Brass Co.	Bridgeport, Conn.	Brass Mill	1	400
		Cold Mill	1	2,250
		Tandem Brass Mill	2	1,600
		Single Stand Cold Mill	2	800
		Hot Copper Reversing Mill	1	1,000
Carnegie-Illinois Steel Corporation	Edgar Thomson Wks., Pittsburgh, Penna.	45″ Universal Slab Mill	3	13,000
Carnegie-Illinois Steel Corporation	Gary, Indiana	Hot Slab Squeezer	1	300
Carnegie-Illinois Steel Corporation	Homestead, Penna.	100″ Plate Mill	1	300
Carnegie-Illinois Steel Corporation	Irvin, Penna.	Tandem Cold Mill	1	300
		42″ Temper Pass Mill	6	2,100
		80″ Hot Strip Mill	12	42,250
		54″ Cold Reversing Mill	3	7,000
		84″ 3-Stand Tandem Mill	4	9,300
Dominion Steel and Coal Co.	Sidney, Nova Scotia	Rod Mill	1	2,500
Ford Motor Company	Detroit, Mich.	Hot Strip Mill	1	3,000
Great Lakes Steel Corp.	Ecorse, Mich.	46″ Blooming Mill	1	7,000
Greer Steel Company	Anderson, Indiana	16″ x 38″ Tandem Cold Mill	1	400
Inland Steel Company	Indiana Harbor, Ind.	44″ Hot Strip Mill	14	28,600
		Edger Drive	1	350
		72″ Tandem Cold Mill	3	3,750
		54″ Tandem Cold Mill	1	1,250
International Nickel Co.	Huntington, W. Va.	14″ Steckel Mill	1	600
Missouri Rolling Mill Co.	St. Louis, Missouri	Rail Rerolling Mill	1	400
Mitsui	Japan	42″ Reversing Cold Mill	3	2,750
McLouth Steel Co.	Detroit, Mich.	Reversing Cold Mill	1	1,250
Otis Steel Co.	Cleveland, Ohio	72″ Cold Mill	2	1,550
		72″ Hot Strip Mill	2	7,000
Republic Steel Corp.	Cleveland, Ohio	Slab Reducer	1	500
		98″ Hot Strip Mill	4	12,000
Revere Copper & Brass	Rome, New York	14″ Cold Brass Mill	1	300
Rustless Iron & Steel Corp.	Baltimore, Md.	12″ Merchant Mill	1	700
Spang Chalfant Co.	Economy, Penna.	Pipe Straightening Mill	1	1,750
Steel Company of Canada	Montreal, Quebec	Merchant Bar Mill	2	3,250
Superior Steel Co.	Pittsburgh, Penna.	Tempering Pass Mill	1	1,000
Tennessee Coal, Iron & R. R. Co.	Fairfield, Alabama	48″ Hot Strip Mill	7	18,500
		Hot Sheet Mill	1	1,250
		45″ Blooming Mill	1	7,000
Thomas Steel Co.	Warren, Ohio	Reversing Cold Mill	1	600
Timken Roller Bearing Co.	Canton, Ohio	Tube Mill	1	800
Wheeling Steel Corp.	Steubenville, Ohio	Hot Strip Mill	1	3,000
Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	42″ Cold Strip Mill	3	1,050
Youngstown Sheet & Tube Co.	Youngstown, Ohio	Tube Mill	2	10,000
			129	251,950

TYPES OF MOTORS PURCHASED

	Total Motors	Total Horsepower
Alternating Current Motors	31	70,200
Direct Current Motors	98	181,750
	129	251,950

GAS CUTTING

The oxy-acetylene process has become of increasing value to industry, both because of the wider recognition and appreciation on the part of industry as to the adaptability, flexibility and economy of the process, and because of important and far reaching developments in the process itself.

Stack cutting or the cutting of piled plates is a recent cutting development and one that has speeded machine shop production considerably. When it is desired to cut a large number of similar shapes from steel plate, it is now possible to pile several of these plates one upon the other and cut the entire stack with one complete movement of the blowpipe. The result is a clean and accurate cut, and every plate in the stack is the same. To obtain the desired results, however, the plates must be piled and clamped properly for the cutting operation.

Another step forward is the development of a method for cutting clad steel plate with the oxy-acetylene blowpipe. This procedure facilitates the preparation of this type of plate for fabrication. Clad materials are finding increasing use in the fabrication of processing equipment where the corrosion resistance of the clad layer is desired in conjunction with the economies of the low-carbon steel base. The old method of flame cutting worked from the clad side and required two operations to complete a cut. The new method works from the opposite side of the plate and requires only one cut. Thus the preparation time is greatly reduced, resulting in considerable savings.

The possible uses of the most recent shape cutting machines are almost unlimited. Complicated shapes are automatically followed with no attention from the operator. Automatic straight-line cuts can be made at any desired angle in the horizontal plane. Automatic bevel cutting in any direction without the use of templets is possible. For repetitive cutting on large scale production items, permanent templets are used. For special shapes, hand-tracing devices enable the operator to cut the desired shape by tracing directly from a blueprint or other drawing.

ELECTROLYTIC CLEANING OF STRIP

The process referred to as electrolytic cleaning is used to clean and remove from the strip the film of oil that results from the solution used to cool the rolls in the cold mills. The strip is removed from the cold mills in coil form and usually transported to the electrolytic cleaning line by industrial trucks which deposit the coil on a ramp where the coil is in position to be rolled into a cone type uncoiler.

After the coil is in position on the uncoiler, the strip is passed over an idler roll and into the rotary seam type welder where the front end of the entering strip and the back end of the last strip through the cleaning line are welded together to form a continuous strip of steel to feed through the line.

The strip next enters the metal washer where it is passed between a series of pressure sprays for the removal of oil from the surface. On leaving the washing machine, the strip passes through a pair of fabric rolls which serve as wipers and also provide tension on the strip to reduce sag. Leaving the fabric roll, the strip enters the electrolytic cleaning tank where the strip is held submerged in an electrolytic bath and is passed between grids spaced at a suitable distance above and below the strip. These grids are polarized and the circuit is completed through the solution and provides cleaning action by means of free alkali formed on the strip and through hydrogen gas formation, which is generated on the strip surface. This gas produces agitation which constantly circulates the solution.

The electrolytic cleaning tank is provided with steam heating coils to heat the solution in this tank and the temperature is controlled automatically.

FILTERS AND CLEANERS

The problem of securing completely clean air for industrial plants is daily becoming of greater importance. An electrostatic cleaner known as the precipitron has been developed which not only removes heavy dirt particles but also removes particles of the degree of fineness found in tobacco smoke. This cleaner is available in commercial sizes and installations are being made in locations where exceptionally clean air is required.

A filter has been developed to remove solids from fluids where the solids are highly invasive in character.

This filter is particularly adapted for the removal of such material as sand, metal chips, abrasive wheel particles and similar materials from water, grinder coolants, cutting oils, soaps, heavy oils and greases.

It may be built with openings for the passage of fluid covering a range of from approximately 450 mesh to 30 mesh. The filtration involved is positive in that no particles larger than the spacing to which the filter is built may pass.

The pressure drop is exceptionally low because the fluid in passing the filter medium moves in a straight line encountering only a momentary restriction. The cartridge or cartridges are rotated by an external motor and reduction gear, and the necessary backwash pressure from a pump driven by the same motors or a separate motor.

The cleaning of the filter element is accomplished by slowly rotating the cartridge so that each portion of the filter surface encounters a momentary reversal of flow which dislodges the accumulated solids. Of particular importance in the filter is the fact that the backwash is obtained from a portion of the cleaned liquid which has already passed through the filter and is returned to the system, thus there is no loss of back wash fluid.

In operation the fluid to be filtered enters through the inlet connection and fills the chamber of sump surrounding the filter cartridge. It then passes radially inward between the wires of the filter cartridge depositing on these wires all solids too coarse to pass. From the interior of the cartridge the fluid moves out through the outlet connection. Backwash fluid is picked up from the outlet connection and is delivered by the pump to the backwash nozzle at a slightly higher pressure than exists outside the cartridge.

AUXILIARY DRIVES

The use of Ward-Leonard control for blooming and slabbing mill auxiliaries is spreading. In addition to

the first equipment of this type reported a year ago, additional ones for three mills under construction were ordered during 1937. Practice has fully demonstrated that this type of drive not only reduces the electrical maintenance, but also the maintenance of the mechanical equipment which it drives.

A radically new departure was made last year in the method of driving the runout tables and coilers of wide strip mills. Instead of using squirrel cage motors and supplying them with adjustable frequency from direct current to alternating current motor-generators, the latest three mills will employ direct current mill type motors (one motor per roller or per pair of rollers) furnished with power from one or more adjustable voltage generators. Appreciable power saving, smoother and simpler control,and saving of substation space are the features of the new method.

Two-speed squirrel cage induction motors have been used for years in connection with drives for machine tools and a large number of other types of machinery requiring two distinct speeds. Their use for hoists has been neglected until recently, and since the use of such motors bestows worthwhile operating characteristics to such hoists at a low cost, their more frequent use for such service is assured. Such motors are in most cases being made totally enclosed and equipped with high grade ball bearings.

MATERIAL HANDLING

On one conveyor installation used in connection with the skin pass mill a downender was furnished which was provided with a wood pallet bed. This wood pallet was built in the downender and served a double purpose. The coils were delivered to the downender riding in a horizontal position on troughed roller conveyor. On rolling into the downender the coils struck the wood pallet, the impact being taken by the wood pallet, and at the same time the wood pallet protected the edges of the finished coils from being damaged. The downender then turned the coil so that it stood vertical and the coil, riding on the wood pallet, was delivered to the receiving table. An overhead magnet then removes the coil from the wood pallet. During this operation the wood pallet separates the coil from the steel table below and makes it easier for the overhead magnet to remove the coil from the receiving table. The operation of the wood pallet, when carrying the coil both from the downender to the receiving table and from the receiving table back to the downender after the coil has been removed, is controlled by an air cylinder built in the downender cradle.

A side tilter which delivers coils to either side was also developed for one installation. The side tilter receives coils traveling in a horizontal position from a downender. With this side tilter it was then possible to deliver coils to troughed roller conveyor which was located on both sides. By using this double acting side tilter it was possible to use one downender to serve two troughed lines of roller conveyor. A double line of troughed conveyor was necessary in order to provide ample storage of coils for two pickling lines.

Trucks

The current year has been a record year in the volume of sales covering material handling equipment. This record is due to the fact that there has been a growing need for new material handling equipment with heavier capacities as well as new types of material handling equipment to meet many new production problems.

Many plants, particularly the steel plants were originally designed and laid out for exceptionally heavy duty mechanical handling and during the course of production the need became apparent for more flexible material handling units which would supply various departments and act as feeders to keep the flow of production moving.

Steel mill operating men are experiencing a radically changed point of view towards truck equipment—formerly trucks were looked upon as purely auxiliary equipment but now they are considered as much a part of the steel producing machinery as the rolling equipment. This changed attitude has brought about a greatly changed attitude on the part of the manufacturers of steel mill trucks from the standpoint of design as trucks must be designed to operate continuously without major maintenance and must be able to be repaired easily and quickly in case of breakdown so there will be no interruption in the flow of steel from hot mill to pickling, to cold mill and to storage.

A type of heavy duty coil handling unit was developed during the past year to facilitate up-ending coils of sheet steel up to 16,000 pounds capacity. This truck is of the center control type, front wheel drive and is equipped with a revolving carriage and is classed as a "traveling upender".

Another new development has been a super duty crane which has a capacity of 7½ tons. This particular crane was developed for the steel industry, however, its application can be extended to other departments where exceptionally heavy crane operation is required to facilitate handling normalizing oven tops.

A heavy duty low lift platform truck having a capacity of 20,000 pounds is equipped with a special motorized conveyor platform to permit operating the conveyor ends for the speedy transfer of sheet steel of various conveyors during process of fabrication.

One of the outstanding machines, at least from a design and construction standpoint, that has been introduced to the steel industry this year, is an articulating frame ram and fork truck. It has a rigid front drive axle, that is, the drive wheels are directly behind the load, and the truck is steered by two rear wheels which are designed to turn at an angle of ninety degrees if necessary. This permits a very short and sharp turning radius.

This machine is practically split in the middle, that is to say, the rear and front sections are coupled to each other by a large bolt at the bottom and center of the attaching plates, four smaller bolts, two on each side near the top, float to and fro in four rectangular slots, in accordance with the condition of the floors over which the truck is operated.

This type of construction assures traction and good steering at all times and under various floor conditions, because all four wheels must remain on the floor at all times to secure traction and steering. With the articu-

lating frames, one of the front wheels can be six inches higher than rear wheel on the opposite side of the truck without interfering with the operation of the machine.

Another contribution to the steel industry as well as general industry is a heavy duty center control type truck equipped with forks and incidentally this is said to be the first telescopic fork truck ever built on a center control chassis. This particular truck can be had in capacities up to 10,000 pounds and with a telescopic lift affords stacking materials to exceptionally high points and still permits a collapsed height of truck to operate under doorways.

A development which has been made for automotive industries in particular and covers a heavy duty die handling truck is the world's largest die handling industrial truck with a capacity of 30 tons. The winch unit is built integral with the platform and this particular type truck affords a safe movement of dies from the heavy presses onto the platform and safe transportation to the storage rooms without the necessity of much labor or time. Ordinarily a die of this gigantic size would take a considerable time to transfer to and from the presses and would entail a corps of men to perform this task.

Storage Batteries

As material-handling trucks become larger and larger, the greater becomes the power required to operate them. To meet this demand a new battery for electric material-handling has just been built.

The cell has a capacity of 1080 ampere hours at the normal six-hour discharge rate. The complete 16-cell battery, assembled in a steel tray, occupies a space of only 26″ x 51″ and weighs two and one-half tons. It has a capacity of 33 Kwh.—almost twice that of an 18-cell battery, which is the largest size of old type that could be assembled in the same space.

As the demand for larger and more powerful material-handling trucks arises, the truck industry will be able to meet it. What the limit will be is hard to foresee. But the limit will not be for lack of battery power. For the big trucks of today, as well as those of tomorrow, can be amply powered by this new battery for electric material-handling trucks.

Another interesting battery installation is in the Chicago Union Stock Yards. This tractor is powered by what is believed to be the largest battery thus far applied to an industrial tractor. It consists of 60 cells, rated capacity 40.5 Kwh. at 72 volts.

Cranes

The trend is definitely toward the use of larger capacity open hearth charging machines and greater refinements in the details of construction. Three large machines which are now being built are of 12 tons capacity, and will be equipped with magnetic sanders for serving each main rail. All the track wheels will be rim toughened. A centralized lubricating system will be installed, and a patented electric thrustor device will eliminate manual operation of the box locking-rod.

Another interesting installation is that of a crane for handling pipes. This crane is entirely automatic in operation. It is started by means of a push button and it then hoists a load and automatically starts the trolley to anyone of several unloading stations, and when the trolley is in position over the selected unloading station it is stopped and the hoist is automatically started to lower the load into position. There is a mechanical arrangement for releasing the load and the hoist then returns to its upper limit, the trolley reverses and runs back to the home station and the hook is lowered into the original position to receive a new load. This entire cycle is accomplished without any attention from an operator after the initial starting. For further details on crane developments over the past year please turn to page 65 for the complete statistics.

Magnets

There has been considerable development during the year in lifting magnets for handling of coiled strip steel. A four coil magnet for handling extremely large coils is in use and a smaller magnet using but two coils has also been developed and sold for use where the coils of strip steel are moderate in size.

One of the magnet builders reports that their most important steel mill development of the past year is the sealing disc which is now used on lifting magnets. This is a metal disc which is welded in place between the main body of the magnet and the pole shoes. With this arrangement the magnet is made watertight, and the fact that the plate is welded in place has permitted a reduction in the weight of the pole shoes because a long surface at the joint is no longer needed to prevent the entrance of water. In addition to the weight reduction a further advantage is that the elimination of the creepage surface permits a shallower pole shoe which brings the winding of the magnet closer to the piece which is being lifted, which of course results in a stronger pull.

An interesting installation of lifting magnets was made for the purpose of handling sheets. These sheets are about thirty feet long and it was desired to lift them one at a time and convey them into position for trimming. It was found that it was impractical to lift one sheet at a time but five or six sheets could readily be lifted by an arrangement of several relatively small lifting magnets mounted in a row. When the sheets are in position before the trimmer, the pull of the magnets is reduced by introducing resistance into their circuit, and the control is so arranged that the bottom sheet is released first at one end and finally from all of the other magnets. The result is that it is possible to drop off one sheet at a time onto the trimmer.

One of the most recent developments reported is the new magnet controller. In addition to a new design contactor for handling the reverse current, this controller is equipped with an adjustable rheostat to permit the operator to set his controller for a quick release for the conditions of voltage, type of meterial and size of magnet that he is using. Should any one of these three conditions change, a slight turn of the rheostat dial provides the proper plugging current for a quick drop of the load under the new conditions. Should the discharge resistors open, control becomes inoperative.

Another new magnet control provides automatically for quick drop of any kind of load without any hand adjustment. It will drop its load of light or thin material in two seconds and of the heaviest material such as a slab or ingot in four or five seconds. When hand-

ling pig iron or assorted scrap it makes possible from six to ten lifts per minute. Six lifts per minute is considered very fast for regular operation. Special resistors connected across the magnet terminals at the moment the circuit is opened reduce the kick arc to a minimum. This not only saves wear of the contacts but keeps the high kick voltage off the line.

WIRE AND CABLES

One cable manufacturer reports they have developed three types of cables suitable for use at high ambient temperatures and therefore particularly useful in the steel industry.

The first is a cable, the construction of which consists of a stranded conductor insulated with flexible glass rovings having a protective sheath of lead. The carrying capacity of this cable, as far as injury to the cable is concerned, would be limited to a temperature somewhat below the melting point of lead. (327° C.) It may also be furnished with glass yarn braid having a finish of flameproof paint in place of the lead sheath. This type is recommended for use in high temperature locations where conditions do not demand a moisture-proof covering. Both these cables are recommended for as high as 1000 volts.

The second type cable has been developed to supplement ordinary varnished cambric cables. This fabric does not lose its flexibility when exposed to temperatures as high as 100° C. for an extended period of time. Moreover, it is superior to varnished cambric in its resistance to the action of solvents. Cables insulated with this tape can be furnished in all sizes and types and are generally recommended for a 5000 volt limit.

The third new cable is insulated with a flexible, non-inflammable, high dielectric synthetic resin which is water proof and extremely resistant to the action of acids and alkalies. These cables are recommended for voltages under 600 volts and temperatures which would prove injurious to rubber insulation. This material can also be used as a protective sheath over ordinary cables as, in addition to these other properties, it is mechanically tough.

The tough, abrasion-resisting, 60 per cent mold-cured rubber jacket on portable cable has been improved so that in addition to its many other desirable qualities, it is resistant to cracking or checking from exposure to the actinic rays of the sun.

A neoprene compound which is suitable for low voltage insulation or as a jacket material over any type of multi-conductor cable is available. This compound is recommended particularly for its resistance to mineral oils, acids and alkalis.

A synthetic insulation is developed which is recommended particularly as an insulation on power or control cable, subject to severe exposure to acids, alkalis, mineral oil and many chemicals.

Multi-conductor rubber insulated power and control cables having rubber fillers instead of the usual fibrous type of fillers in the interstices are now available. The use of rubber fillers makes a more solid cable core and prevents the entrance or wicking of moisture.

A special heat and flame-resisting cover for multi-conductor crane cable and jumper control cable for installation over open hearth furnaces is now on the market.

As a result of the flood conditions it is now possible to purchase control cable potheads for use in terminating multi-conductor control cable.

An improved stop joint has been developed which is recommended for use with paper insulated cables installed with wide differences in elevation in a single cable run. These stop joints effectively limit the pressure of the lead sheath and insure the long life for which the paper insulated cable was designed.

BUS STRUCTURES

Possibly a good way to describe this new bus structure is to outline specifications.

The capacity of the bus itself is 3000 amperes and the feeder risers 1200 amperes. The disconnecting switches have these same ratings, depending on their location.

The bus itself is wrapped to a thickness of $\frac{3}{8}$″ with varnished cambric tape and this, in turn, covered with two thicknesses of cotton tape filled and coated with insulating varnish. The wrapped bus is to withstand a test of 58,000 volts for one minute. Bus insulators are to be in compression only, to have a striking distance of at least 4″ and to withstand 45,000 volts for one minute.

The switches, with bare current carrying parts, are to withstand 73,000 volts for one minute with a minimum striking distance of 6″.

The bus structure and the disconnecting switches are to withstand mechanical strains due to a fault current of 120,000 amperes. This was resolved, under the worst conditions, into a mechanical loading of 10,000 pounds for each four-foot span. The insulators, both switch and bus, are to withstand a compression loading of 10,000 pounds without failure.

The assembled bus and all switch units are to be free from any corona or static discharge between high voltage current carrying parts and grounded parts when the equipment is operating at rated voltage and rated frequency.

For the 3000 ampere bus the conductor selected was five inches outside diameter tubing with a wall thickness of .450 inches. The fittings for elbows, tees, terminals, etc., are cast fittings of bronze with a conductivity of approximately forty-five per cent. The conductor tube is shrunk on these fittings with an excess of .008 inches diameter of casting over the machined inside diameter of the tubing.

For the 1200 ampere bus, two inches double extra heavy inside pipe size copper tubing was selected. No fittings were necessary except terminals. The bus itself was bent to the various angles required.

Field connections of bus section to bus section, or bus to disconnect, are made by means of $\frac{1}{2}$″ x $1\frac{1}{4}$″ soft drawn copper bars approximately 12″ in length. Twelve such bars are used for 3000 ampere connections and six for 1200 amperes.

Bus supports are aluminum bronze ring castings. Four insulators at 90° from each other carry the bus at each support position. The maximum span between supports is 4′–0″. The insulators are in compression only. There is no hardware attached to the porcelain. An adjustable screw base bears against a lead disc in the cupped base of the insulator. The other end is

troughed and bears against the cylindrical surface of the taped bus. Suitable provision is made to lock the adjustable bases against rotation so that there is no chance of the pressure backing off. These insulator rings are the strength members of the assembly. They take all strains due to fault current. The housing is a cover only and contributes nothing to the mechanical strength of the bus structure.

The housing covers are of 3/16" non-magnetic sheet metal. Straight sections are made of manganese steel. Fabricated elbow members, tees, etc., are made of copper silicon alloy. The covers are in halves, split in a plane parallel to the center line of the conductor. The halves are bolted together by a small number of 5/8" bolts engaging welded-on clips. The two halves of the housing mesh in the opposite slots of an extruded H-section in which the gasket material has been inserted. The round ends of the housing are clamped on a machined circumference on the insulator support ring. This circumference has been provided with a groove in which the same gasket is packed. The ends of the gasket in the H-section overlap the gasket on the circumference so that the gas-proof requirement is met.

All field connections are enclosed in cast bronze corona shields. These shields completely house all bolt heads, etc., and provide a smooth, round exterior to facilitate the taping at these points, which must be done in the field.

AIR BREAK SWITCHES

A new switch has been designed to satisfy a demand for a safe, serviceable, and reliable air break switch for lines and substations.

The fundamental principle involved in the design of the switch is simply changing a parallelogram whose angles are other than 90° to a rectangle. The blades of the switch and their associated mechanism form a parallelogram.

In changing the blade parallelogram into a rectangle, one blade travels backward while the other blade travels forward first wiping the contact surfaces clean and then setting up rigid contacts. Simultaneously, with the forward motion of one blade and backward motion of the other, one force offsets another, entirely eliminating cantilever strain on insulators.

A powerful toggle mechanism, actuated by the rear rotating insulator, sets up the high pressure contacts. This mechanism passes center in its final movement securely locking the blades in the closed position.

FUSES

Another development is a fuse for voltages from 2300 to 34.5 Kv. in ratings up to 400 amperes, where the short-circuit duty is severe, and at locations where protective apparatus might be called upon to interrupt faults as high as 30,000 amperes. This fuse is housed in a bakelite and horn fibre tube with a porcelain sleeve on the outside. A field-refillable fuse unit is attached to a non-corrosive spring and shunt cable which make up the internal construction of the unit. When a fault occurs the fusible section is destroyed, and the arc is extinguished by boric acid which surrounds the arc chamber and fuse terminals.

In a new fuse, the boric acid liner around the arc chamber is in a compressed form. As a short-circuit occurs, this boric acid is broken down into a vapor which surrounds the arc area and extinguishes the arc.

CARBON AND ALLOY BRUSHES

The exacting demands made upon carbon brushes by heavy duty mill drive equipment, particularly that used on continuous and semi-continuous strip and plate mills, are being taken care of by the series of electro-graphitic brush grades on which "commutation factor" is used as the basis of production control. This recently defined property of brush material, in contrast with physical characteristics formerly used as a basis for control, has proved to be so closely identified with performance that grade recommendation can be made with much greater certainty than has heretofore been possible. Variation in performance among the individual brushes of a set has been practically eliminated. This has made possible more accurate analysis of machine performance and more ready isolation and correction of faults in the machine or operating conditions.

This new series of brushes, possessing a mild polishing or cleaning action, is designed to polish off injurious surface film formed on the commutator as a result of contaminated atmosphere. On many installations they have proved capable of maintaining a clean, well polished commutator surface where entirely non-abrasive brushes permit the development of disturbing surface conditions. The abrasive property is not sufficient to cause appreciable commutator wear nor to remove existing surface faults such as burned bar edges or flat spots.

Another maker of brushes has developed the twin brush which can be used in the same holder as the single brush is used. This gives the double brush operation without the expense of installing a double brush holder. The performance of this brush is said to make possible the use of electro-graphite brushes without abrasiveness in them, and it gives operation without selective commutation.

During the past year a patent has been applied for covering a metal graphite brush which has a transverse insert. This insert, it is claimed, allows all brushes to carry the same current. Selective action is thus eliminated, and uniform wear with minimum ring wear is encountered.

VOLTAGE REGULATOR

A manufacturer of control equipment reports the development of a new voltage regulator. The general advantages of this electronic voltage regulator are the same as those claimed for other electronic voltage regulators. The general advantages over the electro-mechanical regulators are as follows: No moving part or contact, field forcing, no inertia time lag, no magnetic hysteresis.

These general advantages may be elaborated upon a great deal. In addition to the advantages mentioned above, the new regulator claims several advantages

over other electronic regulators as enumerated below: High degree of sensitivity without complicated circuit, voltage adjustable over wide range, minimum number of tubes, use of standard and reliable component parts and tubes.

The field current in this regulator is furnished by the control rectifier consisting of two vacuum tubes and a power transformer. Both of these vacuum tubes are grid-controlled mercury vapor tubes.

The Thyratron tubes which are used are standard tubes and have been proven in the past through actual operation. The manufacturers state that the life to be expected of each tube is well over 10,000 hours.

Another very interesting development consists of a new automatic power factor regulator which, as its name implies, maintains the power factor of a system within pre-set limit.

LIGHTING

Each year new lighting problems arise requiring the development of lighting units to satisfy these definite lighting requirements. A new lighting unit has been designed for shipping platform lighting. This lighting unit may be mounted in or on the building wall spreading the light up and down the shipping platform but confining and penetrating into the freight car. It is also useful for tunnel lighting.

Crane lighting has heretofore been a most stubborn industrial lighting problem. Excessive vibration and shock common to crane operation subject the lighting unit to unusually hard usage. The size of the lighting unit when suspended on the crane adds materially to the inertial effect which of course is hardly to be desired. A new development for this lighting problem consists of a metal box shaped housing fastened securely to the crane frame. The bottom side of the box contains a controlens for concentrating the light. A heavy duty shock proof lamp is used and all points in the assembly are made shock proof. The compactness of the device reduces the breakage hazard to a minimum while the effective light controlling quality of the controlens increases the lighting result over other crane mounted units.

Repairs and new construction in industrial yards present hazardous conditions. A safety lighting device equipped with red obstruction gloves has been placed on the market. It is a portable, battery operated beacon unit, the battery supplying energy to a spiral neon tube. Through a transformer a nine volt battery supplies 13,000 volts to the neon tube. Continuous flashes from 80 to 200 times a minute are possible and the battery will give continuous night and day service for 90 days.

A new heavy duty lighting unit has been developed for use in steel plants. One of the novel features of this new unit is the special glass used in the lens. By special heat treatment the glass is made so tough that it is not affected by sudden changes in temperature and can be broken only by severe impact. When the glass does break, it splinters into small granulations which are not harmful.

ELECTRICAL TEMPERATURE INDICATOR

A new portable temperature indicator consists of a temperature meter housed in bakelite, to which is connected a thermocouple which, when held in contact with a live wire, bus, oil circuit breaker, terminals, disconnecting switch, motor, or transformer, etc., will register the temperature rise above ambient on the conducting parts being tested. An insulating member of bakelite between the thermocouple contact and meter is provided; also a suitable handle and insulating rod with guard between the handle and the dial of the meter. By holding the temperature indicator against any live electrical conductor, the temperature rise above ambient will be immediately registered on the meter. This meter is especially designed and calibrated for this work. The device may be used on circuits up to 23,000 volts and prevents shutdowns which were previously necessary in order to check apparatus suspected of operating at an elevated temperature.

RECTIFIERS

The development of a plate type copper oxide rectifier has greatly extended the field of this simple means of obtaining direct current. Units of 2,000 ampere capacity at 6 volts have been built. This development will be useful in various types of electrolytic work.

MISCELLANEOUS

Feeder distribution systems, while not new, have found during the past year wider application in the industrial field. Basically, these consist of copper busbars protectively enclosed in a suitable steel housing.

One manufacturer has available a standard product in capacities of 500 to 7500 amperes and special applications have been furnished as high as 15,000 amperes. The most frequent application is the transmission of high current values at 600 volts alternating current or direct current or less between two given points, such as connecting a main switchboard or a secondary distribution switchboard, or as a riser in office buildings to feeder distribution centers.

Each year new developments provide industry with better, safer, standardized systems for supplying power to portable electrically-driven tools, hoists, cranes, drills and other miscellaneous equipment. One of these consists of channel-shaped copper conductors, enclosed in an insulating housing. The current in the busbars is collected by trolleys, which serve and directly connect to the portable or movable electrical equipment, thus providing a feature of mobility.

Cable strain clamps for dead ending low voltage feeder cables, made with duronze U bolts and nuts for alternating current circuits and with forged bolts for direct current circuits in sizes to accept cables from 350,000 circular mills to 1,250,000 circular mills can be furnished with eye or clevis connection which will develop 10,000 pounds strength.

CONCLUSION

For a number of years there has existed between the makers of steel mill equipment and the engineering and operating departments in the steel industry a relationship which has been most helpful, and as long as this condition exists, advancement in the art of steel making is assured.

And in conclusion it is again my privilege to thank all who have so graciously furnished information for this report and all who have in any way assisted for their hearty cooperation in this work.

ELECTRICALLY OPERATED CRANE STATISTICS — 1937

ELECTRIC OVERHEAD TRAVELING CRANES, CHARGERS, PURCHASED BY IRON AND STEEL INDUSTRY

TABLE NO. 1
TYPES OF CRANES PURCHASED

Overhead Traveling	86
Standard	29
Ladle	19
Floor Charger	11
Mill-Type	40
Jib	6
Jib Crane, with Hoist	1
Hoist	1
Monorail Bridge, Hoist	1
Hand Power, Bridge Crane	1
Hand Operated Crane	1
Special	2
Soaking Pit	5
Low Type Soaking Pit	1
Unclassified	3
Double-Hook	2
Three-Hook	1
Four-Hook	2
Tongs	1
Spec. Wire Handling	2
Spec. Handling	1
Mag. Handling	6
Bucket and Magnet	1
Bucket, Hand Hoist	1
Bucket	2
Rev. Fl. Type Charger	1
Charging Machine, O. H.	1
Slab Charger	1
Converter	1
Semi-Gantry	1
Double Dr.	1
Stripper	1
Ingot Strip	5
Cinder Yard	1
Trolleys	26
Bridges	5
Total	270

TYPE OF GEARING

Cranes Equipped with Spur Gears	198
Cranes Equipped with Spur and Worm Gears	62
Cranes Equipped with Spur and Herringbone Gears	7
Cranes Equipped with Worm Gears	2
Cranes Equipped with Helical Gears	0
	269
One Jib (Gears Unclassified)	1
	270

COMPILATION

Total Cranes Purchased	270
Cranes Completely Equipped with Anti-Friction Bearings	175
Cranes Partially Equipped with Anti-Friction Bearings	64
Cranes Equipped with Plain Bearings	30
Cranes (Bearings Unclassified)	1
Trolleys Purchased	26
Double Trolleys	20
Trolleys Completely Equipped with Anti-Friction Bearings	16
Trolleys Partially Equipped with Anti-Friction Bearings	5
Trolleys Equipped with Plain Bearings	5
Trolleys with Spur Gears	18
Trolleys with Worm and Spur Gears	5
Trolleys with Worm Gears	1
Trolleys with Spur and Herringbone Gears	1
Trolleys with Gears Unclassified	1
Bridges Purchased	5
Bridges Completely Equipped with Anti-Friction Bearings	4
Bridges with Bearings Unclassified	1
Motors Furnished	1096
Total Tonnage Purchased	10,037.34
Cranes, Trolleys using Direct Current	256
Cranes, Trolleys using Alternating Current	8
Hand Power	4
Bridges using Direct Current	2

TABLE NO. 2
TREND OF BEARING CONSTRUCTION

Crane Capacity	No. of Cranes	Completely Equipped with Anti-Friction Bearings	Partially Equipped with Anti-Friction Bearings	Equipped with Plain Bearings	Unclassified
3700 lb.	2	0	2	0	0
1 ton	2	2	0	0	0
2 "	5	2	3	0	0
3 "	3	1	2	0	0
4 "	2	1	1	0	0
5 "	23	20	2	1	0
6 "	6	0	5	1	0
7½ ton	8	7	0	1	0
10 "	26	20	4	2	0
12 "	6	4	2	0	0
12½ "	1	1	0	0	0
15 "	31	14	8	9	0
20 "	27	20	6	1	0
25 "	30	23	4	2	1
30 "	14	4	7	3	0
35 "	10	10	0	0	0
40 "	16	13	2	1	0
45 "	5	5	0	0	0
50 "	13	8	4	1	0
55 "	1	0	0	1	0
60 "	11	9	0	2	0
75 "	4	3	1	0	0
85 "	2	2	0	0	0
100 "	2	1	0	1	0
125 "	1	1	0	0	0
150 "	1	0	1	0	0
200 "	10	0	9	1	0
210 "	1	0	1	0	0
225 "	2	2	0	0	0
250 "	4	0	4	0	0
300 "	1	1	0	0	0
	270	174	68	27	1

TROLLEYS PURCHASED

No. of Cranes	Crane Tonnage	Completely Equipped with Anti-Friction Bearings	Partially Equipped with Anti-Friction Bearings	Equipped with Plain Bearings
2	5	1	0	1
2	7½	2	0	0
5	10	5	0	0
1	12	0	1	0
2	15	1	0	1
4	20	1	3	0
5	25	5	0	0
1	30	0	0	1
1	100	0	0	1
1	150	0	1	0
1	200	0	0	1
1	Special	1	0	0
26		16	5	5

BRIDGES PURCHASED

Crane Capacity	No. of Cranes	Completely Equipped with Anti-Friction Bearings	Partially Equipped with Anti-Friction Bearings	Equipped with Plain Bearings	Bearings Unclassified
5	1	1	0	0	0
10	1	1	0	0	0
25	1	0	0	0	1
35	2	2	0	0	0
	5	4			1

RECENTLY COMPLETED

Wisconsin

Ingot in manipulator at 40" blooming mill rolls, with finished blooms in background.

▲ A sum of $6,000,000 has been spent by the Wisconsin Steel Company, a subsidiary of the International Harvester Company, during the last 18 months in modernization of its steel plant. The major portion of this sum has been spent in the building of the new blooming mill. The balance represents the construction of a 21-inch continuous billet mill and the rehabilitation of one of the plant's four merchant bar mills.

Wisconsin Steel Works, located on the Calumet River in South Chicago, passed into possession of the International Harvester Company at the time of the latter's organization in 1902. A predecessor company, the Joseph H. Brown Iron & Steel Company, had been the oldest iron and steel company in what is now the great steel-making district of South Chicago. The Joseph H. Brown Company was founded in 1875.

When the works was acquired by the Harvester Company in 1902 it consisted of a rolling mill, a cut nail mill, and one old blast furnace, known as the "A" furnace. Since then the plant has been enlarged from 55 to 202 acres and today includes 132 by-product coke ovens, three 600-ton blast furnaces, a modern pig-casting machine, nine 100-ton basic open hearth furnaces, a 21-inch billet mill, four merchant bar mills, one cold drawn mill, and the modern blooming mill. Two large bulk ore freighters, the Harvester and the International, are owned by the company and carry ore to its furnaces.

Wisconsin's production capacity has increased from 108,000 tons of rolled steel in 1903 to 564,000 tons in 1937, and from 200,000 tons of pig iron in 1903 to 643,000 tons today. Open hearth capacity now is 600,000 tons.

About one-half of the company's product goes to the various agricultural implement, tractor, and automotive plants of the Harvester Company, the balance going to outside customers.

The modern blooming mill will afford additional production for the trade and is a well-planned scheme of plant enlargement.

The extension of the blooming mill department at this time was contemplated years ago, when a 40-inch reversing blooming mill was constructed. The 40-inch mill constructed at that time was the first unit in the now completed department.

The mill, as stated above, constructed as a first step in the future plans for this department, was housed in a building 325 feet long with a 90-foot span. At right angles to this, at one end, was located the pit building 425 feet long with a 75-foot span. Directly outside the pit building is the stripper building having two overhead stripper cranes for big-end-down molds and a hydraulic ram-type stripper for big-end-up molds. In order to facilitate quicker stripping of big-end-up ingots, new equipment has been added to the stripper cranes.

The pit building is equipped with two charger cranes. In this building is a row of six four-hole pit furnaces, each hole being 9 by 6 feet taking an 85-inch-high ingot. These pits, of the regenerative type, are now heated by mixed coke oven and blast furnace gas. Automatic regulation of the gas mixture and automatic maintenance of gas pressures are obtained by the use of a modern-type gas regulator. Prior to using mixed gas for heating, these pits were heated with gas from five gas producers located in an adjacent building. A reversal on these pits is obtained by a rotating-type valve installation.

The ingots are delivered from the pits to the table rolls by means of an ingot buggy controlled from a pulpit in line with the mill table rolls. The 40-inch blooming mill is a two-high reversing mill driven by a 7,000 horsepower D.C. motor with a speed variation from 50 to 120 r.p.m. This motor is driven by a 3-unit, M.G. set consisting of two 3,000-kw. generators and one 4,000-horsepower, wound rotor induction motor. This induction motor takes 2300 volts.

The manipulation of the bar in the mill is taken care of by an electrically driven manipulator with an overhead finger lift mechanism. The mill is connected to the motor by spindles and pinions. The rolls for this mill are 92 inches long having a bullhead pass and other

Modernization at STEEL WORKS

passes of 12, 8, 6, 3, 5, and 4 inches. The products rolled on this mill, prior to the completion of the new units, were billets from 4 by 3 inches to 8 by 8 inches and slab billets and slabs from 5 to 30 inches in width. At this time, the product on leaving the mill was transferred on a 145-foot rail and cable transfer to the shear approach table and sheared by an electrically driven shear of 160-square-inch capacity.

Following the shear was a movable depressing table. As the table moved back, the crops were dropped into a chute and discharged on a conventional-type chain conveyor. The conveyor carried the crops to pans which were quenched in a quenching tank and thence to cars. Inasmuch as the product of this mill was cut into lengths averaging 12 feet when they left the shear, they were kicked off by a grass-hopper-type kickoff on to a billet conveyor and into stake cars.

The average rolling capacity of the mill at that time was about 40,000 tons per month. Some additional tonnage was rolled on the old steam-driven, 35-inch blooming mill that was built in 1903. The abandonment of the old mill was to be made possible by the construction of the newer units. Therefore, in the plans for the construction of an extension to the 40-inch mill, consideration was given to increased capacity, greater diversification of sizes rolled, together with improvement in the quality of the mill product. In order to provide more suitable billets for existing finishing mills, great flexibility was necessary in the newer units.

To accomplish this, the construction of an additional reversing bloomer and a continuous mill was begun. These units are housed in a 475-foot addition to the main mill building, making the main mill building 800 feet over-all, with a cooling bed building 200 by 73 feet alongside. The addition to the main mill building is of standard conventional design with the exception that sloping skylights are provided in the monitor.

The contemplated extension to this department was completed and put into operation in September, 1937, with the possibility of at least doubling the former capacity, if needed.

Housed in the 800-foot main mill building is the 40-inch bloomer, a bloom crop shear, the 32-inch bloomer, a billet and slab shear, two transfers, a 6-stand 21-inch continuous mill followed by a flying shear, finishing end tables, shear, and cooling beds.

Following the 40-inch bloomer delivery tables is a 58-foot one-way cable transfer, and in line with the mill is an up-and-down-cut crop shear of the newer type driven by a 150-horsepower A.C. motor. This shear has a capacity of 180 square inches. It is equipped

View of 32" blooming mill, with manipulator in foreground.

throughout with roller bearings and has an individual lubrication system. The blooms that come from the 40-inch mill are cropped of pipe on this shear and then transferred on the 58-foot transfer to the 32-inch mill approach tables. The crops drop directly into a chute, from there to the skip buggy, and from the buggy directly into cars. The 32-inch mill tables are provided with roller bearings and are automatically lubricated by a modern grease pressure system.

The 32-inch mill is a two-high reversing unit connected by means of spindles and pinions with a 4,000-horsepower D.C. motor. This motor is driven by a 3-unit, M.G. set consisting of two 2,000-kw. generators and one 3,000-horsepower, wound rotor induction motor, taking 6,600 volts.

The manipulation of the bar at this mill is taken care of by a manipulator with heads on both sides of the mill. It is possible to turn the bar on either side of the mill. The speed on this mill may vary from 75 to 165 r.p.m. The mill takes a 72-inch roll, having a bullhead pass, and other passes of 8, 6, 3, 5, and 4 inches. This mill rolls billets from 4 by 3 inches to 8 by 8 inches and slab billets and slabs from 5 to 24 inches wide.

The screws are worm driven, and the mill is equipped with a phenolic resin-type bearing. The screws are lubricated separately. The pinion stand has an individual lubricating system with a tank and a small electrically driven pump. Lubrication of the mill roller

150′ transfer conveying billets from 32″ blooming mill table to billet shear approach tables. Billet in left background is entering shear.

bearings and the manipulator roller bearings is taken care of by the main grease system.

From the 32-inch mill the bar is delivered to a 150-foot two-way cable transfer, where it is transferred to the delivery tables of a down-cut shear that is in line with the crop shear and 40-inch mill unit. The two transfers are connected by means of a table so that wide slabs and blooms may be rolled on the 40-inch mill and sent through the crop shear to the down-cut shear and then delivered to cars.

The down-cut shear, driven by a 200-horsepower A.C. motor, has a capacity of 180 square inches. This shear is provided with a hydraulic hold-down ram, individually driven crop pusher, and a 30-foot electrically operated screw gauge. A crop delivery unit attached to the end of the depressing table immediately following the shear has been provided. This unit is built on the endless-chain principle and delivers crops from this shear sideways to a chute, from the chute to a skip buggy, and from the skip buggy directly into cars.

The table following the shear is equipped with a disappearing stop. Billets sheared to lengths of 15 feet or less are stopped at this point, and an overhead, electrically driven push-off discharges the billets onto a billet conveyor and thence into stake cars. Following the disappearing stop and push-off is a run-out table provided with a hot-saw. It is possible to hot-saw billets as long as 30 feet.

These billets may be kicked off by an endless chain kick-off into a 30-foot cradle just beyond the hot-saw. These billets are transferred from the cradle to a covered billet yard adjacent to the mill building by means of a billet transfer car where the billets are slow-cooled, should that be required, or where they may be loaded into standard-gauge cars.

The 150-foot transfer is a double transfer, and it is possible, therefore, to roll blooms for the 21-inch continuous mill which is in line with the 32-inch mill on either the 40 or 32-inch mills, thus providing greater flexibility.

As stated before, the 21-inch continuous mill is in line with the 32-inch mill. The 21-inch mill consists of six roll stands and two edger stands. These stands are spaced as far apart as available room would permit. The distances between the stands are as follows:

No. 1 Stand—No. 2 Stand, 14 feet
" 2 " — " 3 " 18 "
" 3 " — " 4 " 14 "
" 4 " — " 5 " 18 "
" 5 " — " 6 " 12 "

The roll speeds on the various stands are as follows:

No. 1 Stand, 18– 36 R.P.M.
" 2 " 24– 48 "
" 3 " 33– 66 "
" 4 " 43– 86 "
" 5 " 56–112 "
" 6 " 70–140 "

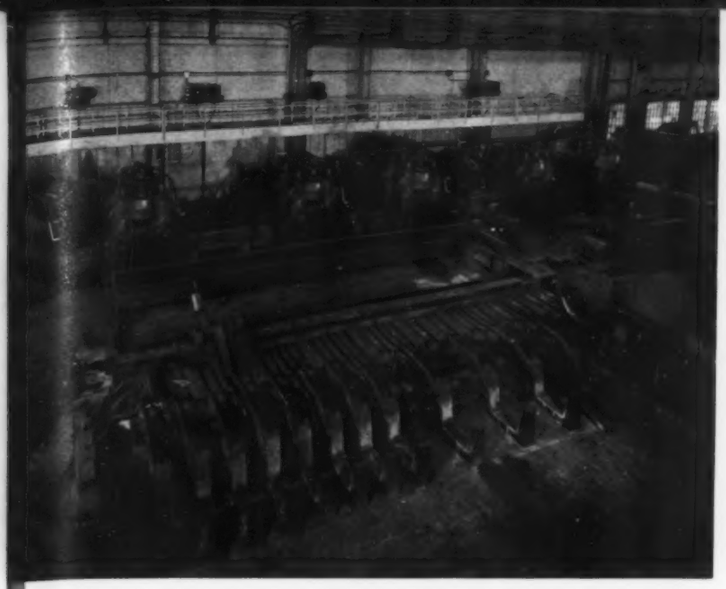
Housings have been provided for both billets and wide flats. The billet stands are of very rigid construction and take a roll with a 32-inch body. Roller twist guides have been installed throughout the billet mill, and each stand is separately driven, permitting independent control and regulation of speed of each. The first two stands are each driven by 1,500-horsepower D.C. motors and the remaining four stands by four 2,000-horsepower motors.

These motors are driven by a 3-unit. M.G. set consisting of two 3,500-kw. generators and one 9,970-horsepower synchronous motor. This motor takes 6,600 volts. The stands for both billets and bars have been equipped with phenolic resin-type bearings. The speed regulation of the stands is taken care of by an operator in the control pulpit located on the wall opposite the mill.

Fixtures on the mill are of the conventional type. A choice of materials for guides, etc., was made with every precaution taken in order to maintain and produce a product of the very best quality.

The billet mill is designed to produce billets from 1¾ to 4 inches. It is designed sufficiently rugged in order to roll wide bars. Edging mill stands are placed

Floor view of 21″ continuous mill with rotary flying shear in foreground.



View from control pulpit of 21″ continuous mill. Shown in foreground are a 30′ cradle and hot saw.

in front of No. 1 roll stand and between No. 2 and No. 3 roll stands. In rolling some of the smaller-sized billets, No. 1 edger is used to enter the bloom in No. 1 stand on the diagonal.

The wide-bar mill stands are of extremely sturdy design without caps or bottom adjusting screws. The top roll is held against the screws by a spring hanger arrangement, and adjustment is obtained by means of a worm mechanism on top of the stand. The rolls of this mill are short, having only a 24-inch roll body. The mill is designed to deliver a product 3/16 inch in thickness and 18 inches in width. Looping between the stands is taken care of by automatic adjusting roller loopers.

The six stands of this continuous mill are individually connected through the conventional-type spindle, modern and individually lubricated herring-bone-type pinions and gear reduction sets to the motors. The continuous mill is preceded by an individually driven swinging crop shear and followed by an electrically driven, rotary-type flying shear, designed to give a square cut on billets up to and including 4 inches, varying in length from 12 to 36 feet. This shear is driven by two 100-horsepower D.C. motors and is synchronized electrically with the finishing stand, and is controlled from the pulpit directly above it.

The run-out tables from the flying shear have variable speeds in order that they may be controlled and synchronized with the speed of the shear itself. These run-out tables deliver the billets to a skew table just preceding two 30-foot cooling beds which are 60 feet long and extend from the main mill building into the cooling bed building. Between the beds an up-and-down-cut billet shear, quite similar to the crop shear, has been provided in order to cut lengths shorter than 12 feet. This shear is driven by a 150-horsepower A.C. motor and has a capacity of 80 square inches.

It is possible to deliver a bar from the cooling bed tables directly into a pinch roll and bar piler. The bars are taken from the bar piler with a remote-control, 15-ton, 37-foot-span crane to the cooling bed in the cooling bed building.

All newly installed tables are provided with roller bearings and are equipped with oil-filtering and grease-lubricating systems.

In the extension to the main mill building is a 15-ton, high-speed crane, having roller bearings and individual lubricating system. The cooling bed building is also provided with a 15-ton crane running parallel to the cranes in the main mill building.

Provisions have been made for descaling by the installation of a 1,000-pound pressure system. This system is also used to wash scale under the 32-inch mill and the 21-inch continuous mill. The scale system consists of two 1500 G.P.M. 500-pound pressure pumps running in series making 1,000-pound pressure for descaling and 500-pound pressure for washing scale.

The motors of the continuous mill and 32-inch bloomer are housed in separate motor rooms of modern design with air-cleaning equipment. These motor rooms are both serviced by a 60-ton crane on a continuous runway connecting the two motor rooms. Between these two motor rooms is a scale pit for the newly constructed units. The 60-ton crane has an auxiliary 10-ton hoist which is used for loading scale from scale pit.

The construction of the addition also included some relocation and additions to the roll shop of this mill to take care of additional lathe equipment for turning rolls for the new units.

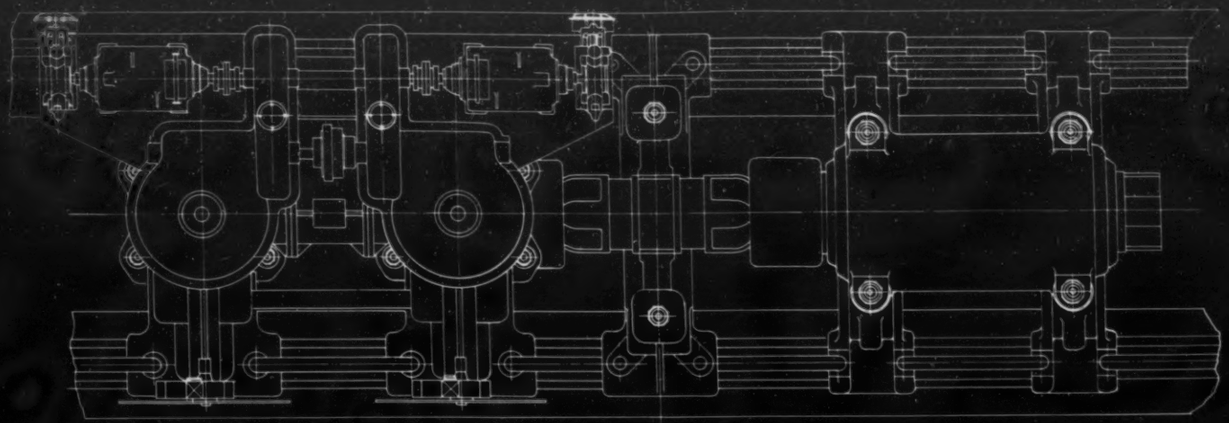
The telautograph system, in use for some years, was extended throughout the newer part of the mill, making possible instantaneous communication between the clerks at finishing end of the mill and the rollers and steel chargers.

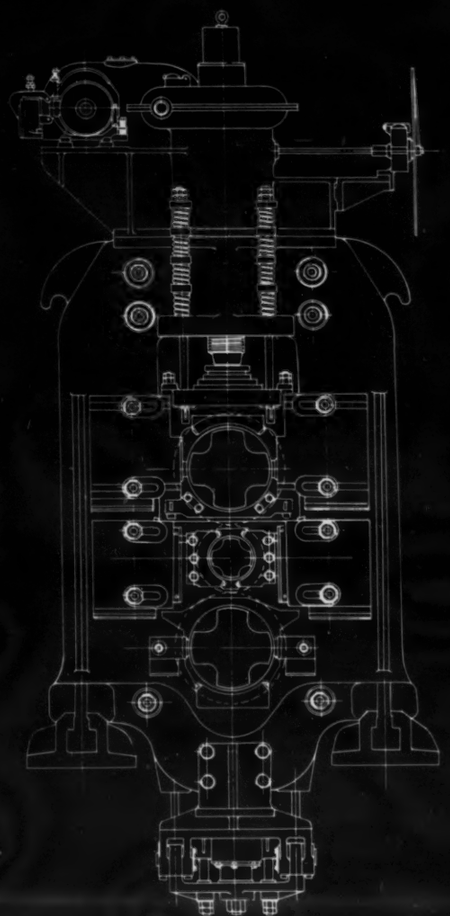
Upon the completion of these new units a greater range of products has been made possible. Blooms up to 12 by 12 inches and slabs up to 30 inches in width may be rolled and sheared in the new set-up. Longer billets up to 30 feet in length may be rolled and hot-sawed.

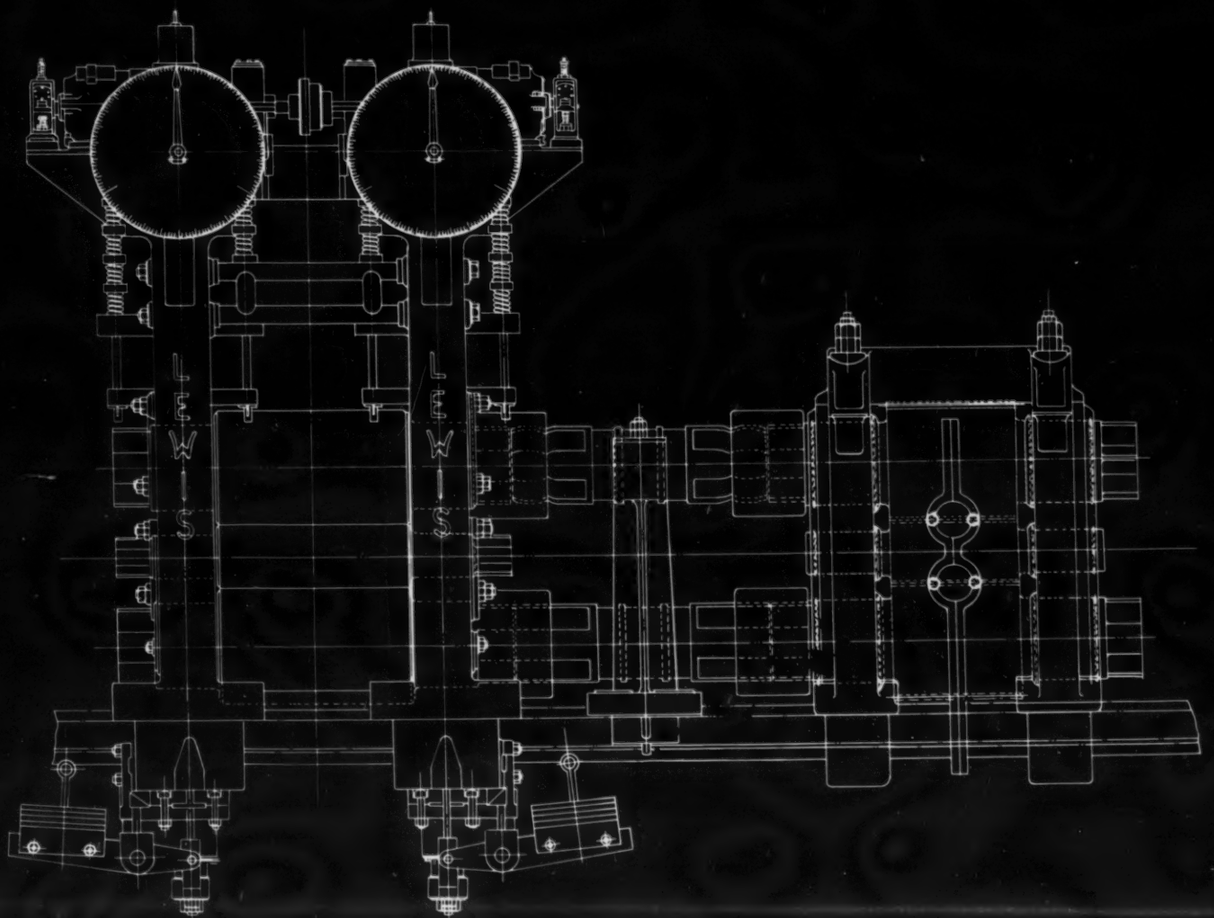
The 21-inch continuous mill makes possible the rolling of billets from 1¾ to 3 inches square, in varying lengths up to 30 feet. It is possible to roll on this mill flats from 3/16 to 1½ inches thick and up to 24 inches thick and up to 24 inches in width. This diversification in size of billets has permitted the rolling of more suitable billets for the existing merchant mills in order that they may meet the exacting requirements of the trade in merchant mill products.

Motor room of 21″ continuous mill.

DRAWING of the . . . . .
LEWIS 3-HIGH MILL
SHOWING END, FRONTAL
and OVERHEAD VIEWS







A Look at THE THREE-HIGH *Sheet Mill*

The technical data and illustrations for this article were contributed by Lewis Foundry and Machine, a Division of Blaw-Knox Company, Pittsburgh, Pa., makers of the Lewis three-high mill.

View of a three-high mill being erected for testing prior to shipment to a European steel plant.

▲ PROGRESS in industry is not that direct or one-way movement which we like to believe. There is much retracing, and many gaps along the route need plugging. New developments are never so conclusive but that supplementary measures may become needed to provide specialized treatment and flexibility. The chain-like production and assembly systems currently emphasized, for example, can become inflexible unless buttressed by facile auxiliary units.

On the other hand, the possessors of simple methods with flexible unit-like equipment can command larger participation in industrial operations than is sometimes apparent. By suitable adjustments, they can adapt their operations to specialty products and open the way for individualized treatment of the new or exacting requirements of their customers.

It is with these thoughts in mind that we survey the sheet rolling field and attempt to estimate the significance of the modern three-high sheet rolling mill. Our treatment of the subject is based on a consideration of the three-high mill as an auxiliary machine to the other established instruments of production in the sheet producing field.

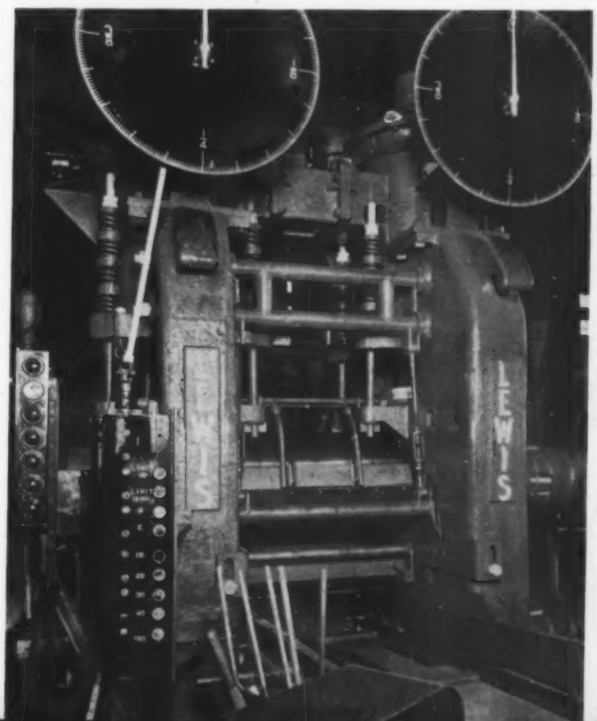
The idea of a three-high sheet mill is not new. There is reference to the existence of such a mill as early as 1847 and report of its operation in a Pennsylvania plant. But, in the inexplicable behavior that new developments often take, the idea was not then productive of a trend, and it was not until the late 1920's that the modern experimental work was conducted. This recent activity resulted in the three-high mill as we know it and provided rolling in both directions without the necessity of a reversing mill.

For an appreciable stretch of years, therefore, sheet rolling has been accomplished principally by hand operated two-high mills. Originally, of course, both the breakdown and finishing operations were performed on the same units. Pressure for better finish led to specialization, with certain mills set apart for roughing work and others designated for finishing passes. This separation in tasks permitted the use of special rolls on the finishing mills to provide an improved smoothness of finish, while under the original method roll polishing was practiced during the interval consumed for pack heating.

Since these mills were non-reversing, much time was consumed in passing material from the catcher to the roller, as well as in making adjustments and controlling the entry and piling of the work or product material. The mechanical two-high and the early three-high mills were intended to eliminate much of that lost motion, with the latter obtaining the additional advantages of two directional rolling.

While enabling improved production performance, the early three-high units were makeshift affairs. As a rule, they represented conversions from two-high mills, with the housings machined out and the details of additional assembly crudely designed. Nevertheless, they served as additional motivation to the design of

A close-up of the three-high mill from the roller's table, showing the control board and screwdown indicator dials. This mill is equipped with the automatic screwdown.

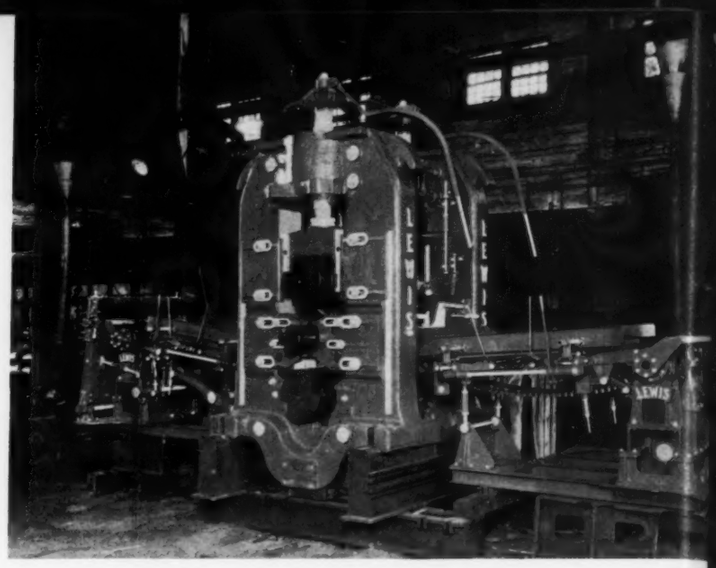


the current mechanized and electrically controlled three-high mill.

The principal aims in the design of this type of mill have been to enable quick and easy roll change, provide speed at the roller's and catcher's tables, and permit easy and accurate adjustment of the screwdown. It is felt that a high point has been reached in the electric control of the motor-driven screwdown. By means of this provision, the operator sets a control board in accord with a predetermined number of passes required for a desired reduction. Subsequently, and from the original entry to the final pass, the screwdown is automatically regulated.

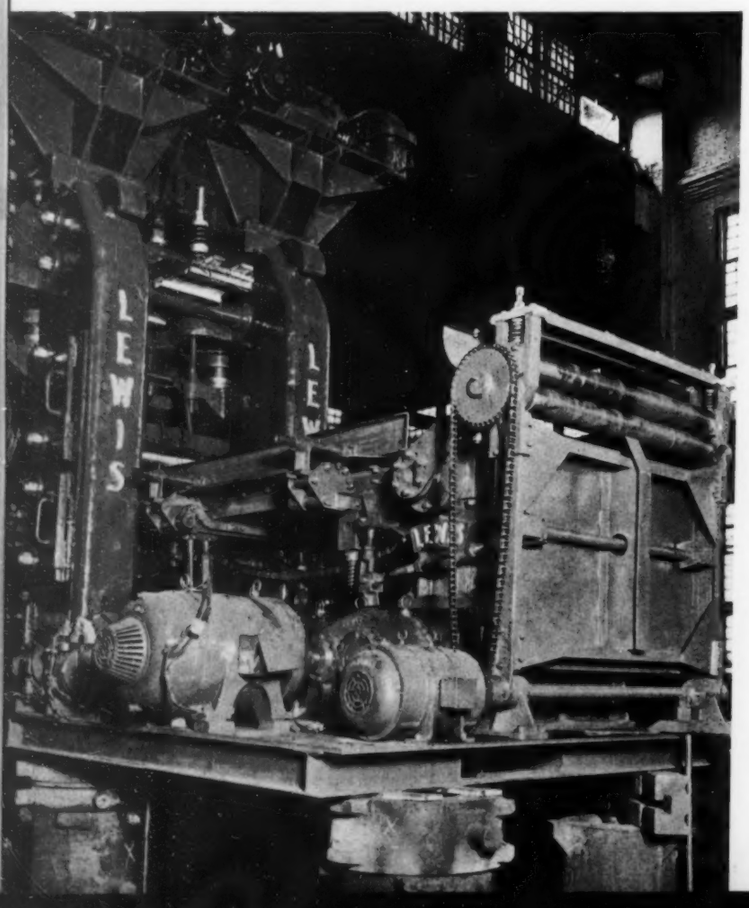
An electric lamp panel, visible to both roller and catcher, indicates what pass is about to be made. Upon completion of the scheduled number of passes, the mill resets to entering position. Indicator dials above the mill show, to the thousandth of an inch, the reduction being made. The end of the catcher's table leads directly to an automatic piler which stacks the rolled material.

Two types of these three-high sheet mills are manufactured: The "jump" mill, and the "balanced" mill. The jump mill has power applied only to the bottom roll while the balanced mill applies the motive force directly to both top and bottom rolls. On the former type, rolling is accomplished by transmittal of force through surface contact of the several rolls. When material is being passed through the lower two rolls, the middle roll acts as a rider which is given impetus to rotate by the frictional contact with the work material. When material is being passed through the upper two rolls, the top roll is the relatively free agent and revolving force is given the middle roll by direct contact with the bottom roll.



A "jump" mill type of the three-high mill, equipped with a hand operated screwdown but having an automatic piler.

A close-up of the catcher's table, showing the automatic piler.



Due to the force of the jump after passing, that is, the drop taken by the riding or "free" roll, the jump mill is more limited in the thickness of the charged material, or of the sheet bars to be used. Because of this limitation, the jump mill is less expensive than the balanced mill. It may be equipped, however, with the electric control and screwdown.

The mill can be used as a roughing or a finishing mill, and is currently finding application in four principal ways. It is being used:

1—As a roughing mill for rolling breakdowns for sheets of all types;

2—As a roughing mill for rolling tinplate breakdowns;

3—As a jobbing mill for standard and heavy gauge sheets;

4—As a finishing mill for ordinary sheet stock, and for rolling wide, full finished auto-body and furniture stock.

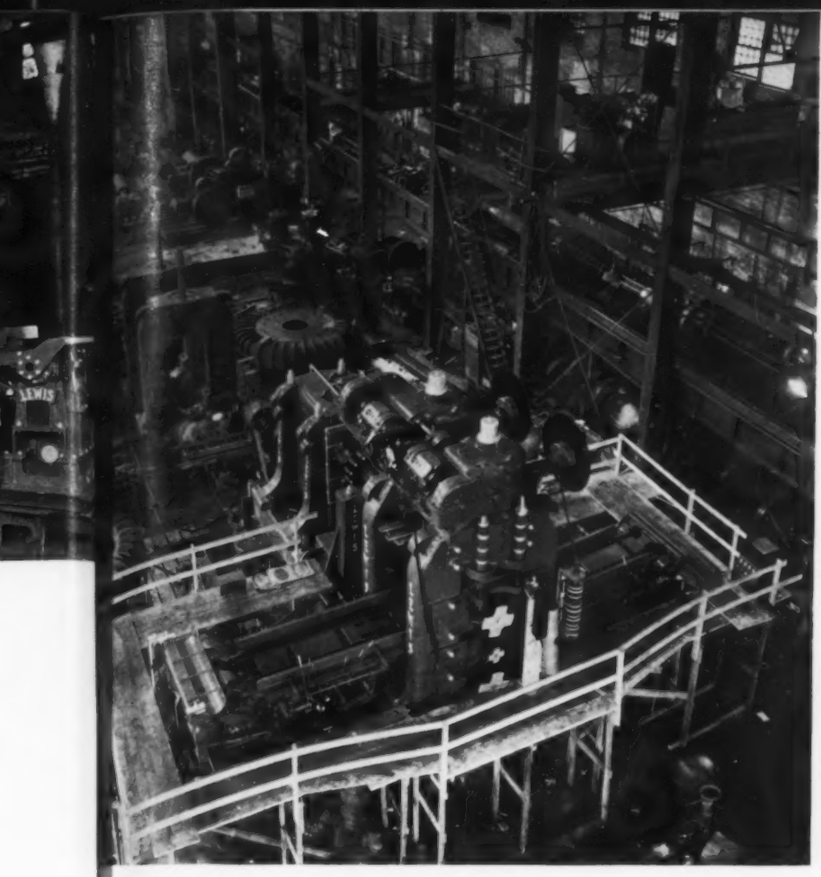
The first installations of this Lewis mill were made in an American plant a little over 5 years ago. A total of 22 installations have been made to date, and the past year was featured by 9 new units. A survey of the 22 installations reveals:

1—A total of 13 mills in the United States. Of these, 7 are used principally as sheet breakdown mills; 2 are used for tinplate breakdowns; 1 is a jobbing and breakdown mill; and 3 are used as finishing mills for auto-body and furniture stock.

2—A total of 9 in foreign countries. Of these, 6 are used for sheet breakdowns; 2 are used for tinplate breakdowns; and 1 is a general jobbing mill.

3—The foreign installations are distributed among England, Sweden, Canada, Australia, Japan, Russia, and India.

4—Of the American installations, 11 are owned by steel companies who are also possessors of continuous strip mills. In some cases, the three-



Erection of two three-high mills. These mills will be used for tinplate breakdown rolling in a Russian steel plant.

high unit is an adjacent auxiliary to the continuous mill.

5—The automatic screwdown is present in 16 of the 22 installations.

While flexibility and ease of operation are promised by the design and construction of the mill, the best criterion of its utility is contained in a survey of actual performance in an American sheet plant. The plant in question possesses a group of the older type two-high mills, several mechanical two-high units, and one Lewis three-high mill.

The three-high mill has been used for some finishing work on heavier gauge sheets but, because of available finishing capacity in the mechanized two-high units, its principal use is in breakdown work. Thus, at this particular plant, it serves as a feeder to several other units and is found to be able to keep at least two mechanical two-high units busy.

Sheet material of 20 gauge has been successfully rolled on the three-high unit, and trial rollings of 22 gauge are contemplated. There is no necessity for a uniform schedule of widths, generally required on old type mills, as the water coolant takes care of temperature expansion in the rolls. This in turn contributes to a materially reduced roll breakage. Attention was also directed to improvement in working conditions because of the cooler temperatures and features of electrical control.

Because it is a water mill, cleaner and smoother surface is reported. There is a water jet near the middle of the roll, pouring on the center line of the sheet, which facilitates the formation of a slightly convex shape in the sheet. This is a desired condition as it permits uniform piling and easy rehandling. The roll temperature on the three-high mill remains under 250° F. and is relatively constant.

Where no water is used, as in old sheet mill practice, there is a large temperature range with the greatest variation in the middle of the roll. Consequently, such rolls required designing with a special concavity at the mid-surface to allow for greater expansion in the center of the roll, an inevitable occurrence when maximum working temperatures were attained. Roll temperatures of 700/800° F. were usual during steady rolling.

On the other hand, before the rolls attained that maximum temperature, and before the concavity was filled out by expansion, the sheets did not acquire uniform thickness. In other words, the early production on each run was off-gauge. Precautions against this variation in operating conditions required the taking of temperature reading several times during a turn, frequent adjustments of the screwdown, and careful provision in the schedules for the correct rotation of widths—with the wider widths being rolled first and followed by gradually diminishing widths.

With respect to production performance, the following figures reflect the experience of this user and serve as a guide to the relative possibilities. On the three-high mill, 1800 to 2000 pairs of sheets, at five passes for each pair, are rolled during one eight hour turn, while the production range on the other units for equivalent work is from 500 to 800 pairs.

Roll selection has presented the most difficult problem

Operating photograph of the three-high in use in an American sheet plant. The operator is looking at the dials to verify screwdown adjustment before entry of work material into the rolls.

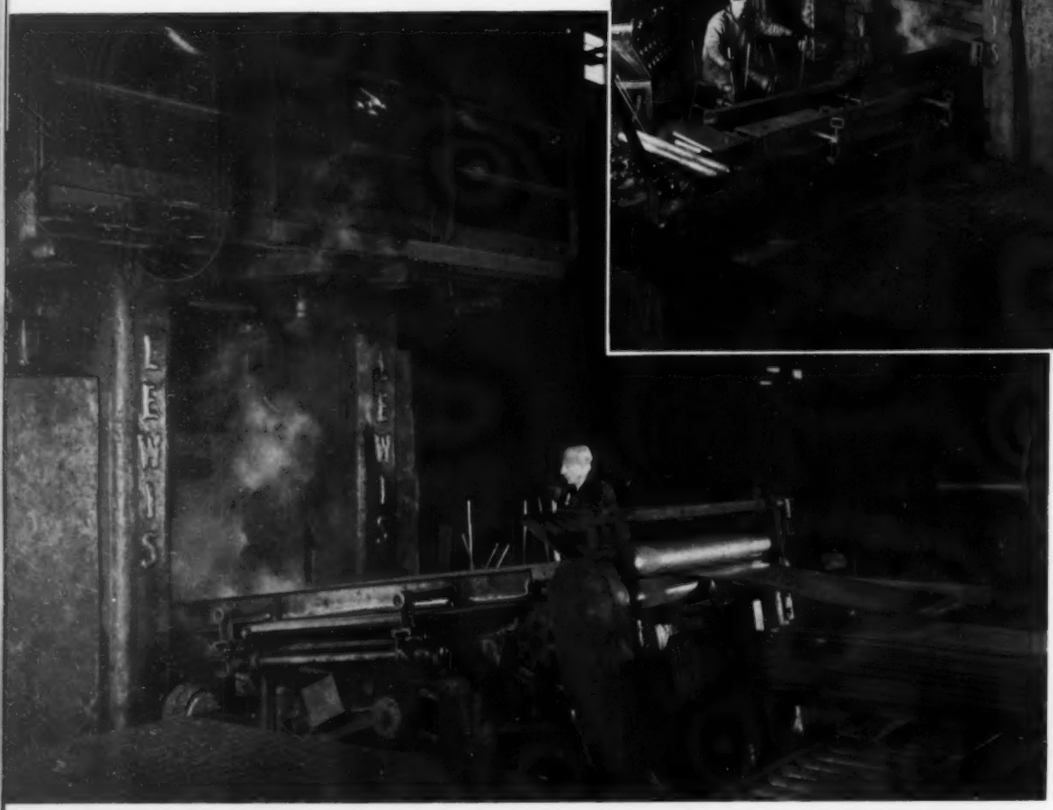
to this producer. This is partly because of the conflicting requirements from a surface finish standpoint, and there is of course no all-purpose roll to meet all conditions. This is a problem common to many mills.

Too soft a roll results in a net surface which may be suitable for some orders but undesirable on others. For example, an etched surface is desired on vitreous enameling stock, to a smaller degree, it is suitable for galvanized material. Its occurrence on the early passes necessitates, however, harder rolls on the finishing units and cold mills to prevent too large a build-up of etch pattern.

The old type chilled rolls with their hardened surfaces produce a smooth finish but exhibit some tendency to spall because of the large amount of work demanded of them in the rapid production of three-high mills. Because of these considerations, and to secure the utmost in the way of roll life, the plant in question is conducting experimental work to determine the most suitable selection of roll types. To meet the same needs, the maker of the mill reports the development of rolls designed specifically for use in the three-high mill. These new rolls, a special iron type, are said to be productive of a high grade finish with improved service life.

To conclude from this review of experiences, the three-high mill is a facile instrument which has a logical place in the steel production picture.

Right—Another view of the three-high mill at work. The driving machinery is visible in this photo.



Left—View of the catcher's side in operation. A sheet pair is just being stacked by the piler.

SELF-DUMPING HOT METAL TRANSFER CAR

▲ A new type of self-dumping hot metal transfer car has just been produced by Koppers Company's Bartlett Hayward Division.

It has been designed by Koppers engineers under the supervision of John D. Pugh, inventor of the original mixer type ladle. The first of the new cars has been built for Alan Wood Steel Company, Conshohoken, Pa.

The car ladle is of the closed mixer type with a single central spout opening, but instead of being symmetrical about its axis of rotation, as ladles of this type formerly have been, this ladle has a greater taper below its axis than above. This results in reduced length for a given capacity and pouring spout height.

The ladle is all welded, having cast steel heads and pouring spout and a rolled steel shell. Welds between steel castings and rolled steel plates are stress relieved. This welded construction reduces weight and eliminates any hazard from loose rivets under repeated shock and strain.

Instead of elongated double-bearing trunnions formerly employed for supporting and rotating self-dumping mixer type ladles, the new ladle has trunnions which are relatively short and spherical in form at their extremities. These trunnions are supported in pedestals having concave spherical surfaces which, in cooperation with the spherical trunnions, form ball joint supports. No effort is made to keep the pedestal supports axially in alignment with the ladle itself. This eliminates any intermediate swiveled platform and permits mounting of the pedestals directly upon the car trucks. This reduces weight, and permits the trucks to assume any angular position required by track curvature or grade, by superelevation of rail on curves or low rail joints.

The mechanism for rotating the ladle for unloading also is mounted directly on the truck at one end of the car and is a new design. An electric motor drives through a pair of helical gears to a double worm gear reduction unit. This, in turn, transmits rotary motion to the ladle through a simple device which permits simultaneous angular and parallel misalignment without disturbance to the mechanical connection between the driving and driven elements of the car. While there are no loose fits or excessive clearances, no binding or cramping action results between the elements, either while rotating in any position, or while in transit.

The driving assembly is dust proof and all wearing parts are submerged in an oil bath. The hand wheel on the bearing pedestal may be quickly attached to the extended end of the motor shaft to rotate the ladle by hand in case of electric power failure. Plug-in connections for the motor are provided at each dumping station and electrical controls are so located that the operator can unload the car from a desirable point of observation.

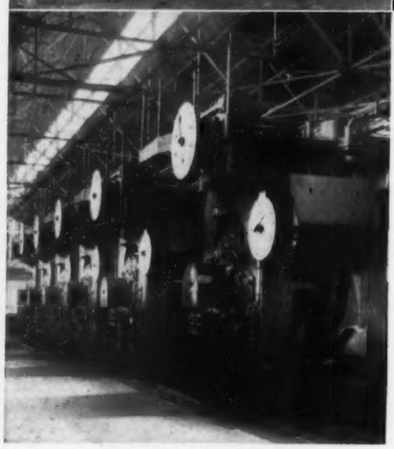
These cars are mounted on four, six or eight wheel trucks, depending upon the size of the car and the wheel loadings permissible. The 125-ton capacity cars are mounted on two eight wheel trucks and, when carrying a charge of molten metal twenty per cent in excess of rated capacity, due to wear in the refractory lining, they weigh, together with the charge, approximately 529,000 pounds.

Trucks can be equipped with plain brass journal or anti-friction bearings. Air or hand brake equipment, or both, can be provided.

(*Please turn to page 77*)

New self-dumping hot metal transfer car. The ladle has greater taper below its axis which makes it possible to reduce length for a given capacity and pouring spout height.

Bantam Preference
A RESULT OF SUPERIOR PERFORMANCE



Typical Bantam installation on an 18" and 42" x 38" Hot Strip Mill. Bantam Tapered Roller Bearings were used on the Backing Roll Necks and Working Roll Necks of this mill.

When one observes the recognition given Bantam Tapered Roller Bearings by the steel industry during the past several years it is only natural to ask, "What has brought about this preference?"

The answer is just this: *Lower Bearing Cost Per Ton of Steel Rolled.*

BANTAM BEARINGS CORPORATION
SOUTH BEND, INDIANA
Subsidiary of THE TORRINGTON CO.
Torrington, Conn.

BANTAM BEARINGS

TAPERED ROLLER • • • STRAIGHT ROLLER • • • BALL BEARINGS

IMPROVED TYPE CRANE RAIL SANDER

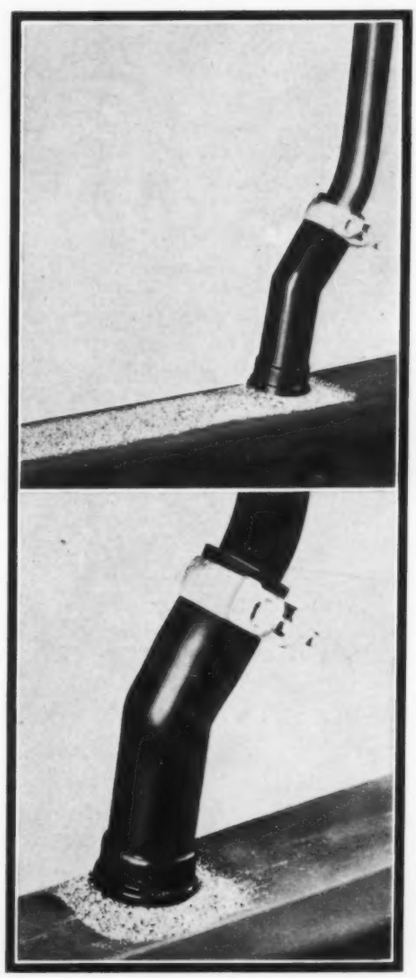
▲ A decided improvement in mechanical crane rail sanding has been achieved through the new nozzle and redesigned valve now being featured by The Lintern Corp. of Cleveland on their crane sander.

This new nozzle has a smaller opening than the former type and deposits a small stream of sand on the center of the rail using only a fourth of the amount previously used, and requiring only infrequent filling of the hopper.

The nozzle of hard, durable rubber, is set close to the rail so that when the crane stops, the sand automatically stops—no more sand can come out. It thus eliminates the objection sometimes raised to sanders that they spill sand on the men and materials below the crane.

Of recent years sanders have come into general use for inside as well as outside cranes. They insure safety and quick sure spotting of crane regardless of moisture, grease or rail sweat. Lintern Crane Sanders are of the type approved in the safety specifications of the Association of Iron and Steel Engineers and in the crane specifications of leading steel corporations.

This improved type crane sander deposits a small stream of sand on the center of the rail but when the crane stops the flow of sand stops as shown in the upper and lower illustrations.



WELDING BULLETIN

▲ "How to Change Over to Welded Design for Profits" is the title of a new bulletin just published by the Lincoln Electric Company, Cleveland, Ohio. Intended as an aid in applying electric welding to the design of machines and machinery structures, the new bulletin sets forth the experiences of many manufacturers who have redesigned their products for arc welded construction.

Of particular interest are illustrations of products as they were formerly built by some other method and their modern arc welded counterparts. Their construction is clearly shown, together with a comparison of results obtained with the old method and the modern one. Many arc welded machine parts such as levers, wheels, brackets, frames, bases, containers and covers, which are common to practically every piece of machinery, are illustrated by photographs and line drawings. A study of these small parts and application of the method of welding them enables the designer to visualize larger and more complicated structures arc welded. The idea that every machine is an assembly of easily designed parts is the message carried to the designer. Changing the product from traditional methods of construction to arc welding is accomplished most simply by converting the component parts one at a time. This step-at-a-time procedure, according to the bulletin, will assure most satisfactory results and greatest economy from application of welding to product design.

Included in the bulletin are photographs of production executives of many leading industrial concerns which are manufacturing products of arc welded steel. Statements by these men are enthusiastic regarding the quality and economy of arc welded construction.

This booklet will be sent to those writing, The Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio.

CURRENT BREAKER MILL DUTY SAFETY SWITCH

▲ That their Bulletin 4101 "Current Breaker" mill duty safety switch is available with a window in the cover to make inspection of the blades possible from the outside, is announced by Cutler-Hammer, Inc., manufacturers of electric apparatus, 259 N. 12th Street, Milwaukee, Wisconsin.

This window is three-sixteenth inch shatter-proof glass held securely in place from the inside. A sponge rubber gasket is used to cushion the glass and seal the opening in the cover.

The Bulletin 4101 window type line is basically the same as their standard type A mill duty line, characterized by its quick make and quick break mechanism pressure-type fuse clamps; non-current carrying hinge posts; double-break air-blanketed contacts; silver plated blades and jaws; unit pole construction and interlocked cover with key release and provisions for padlocking.

The window type line was developed to meet a demand for quick and safe inspection, and is available in

Current breaker mill duty safety switch with a window in the cover to make inspection of the blades possible from the outside.

standard sizes from 30 to 1200-amperes up to 600 volts, fusible and non-fusible.

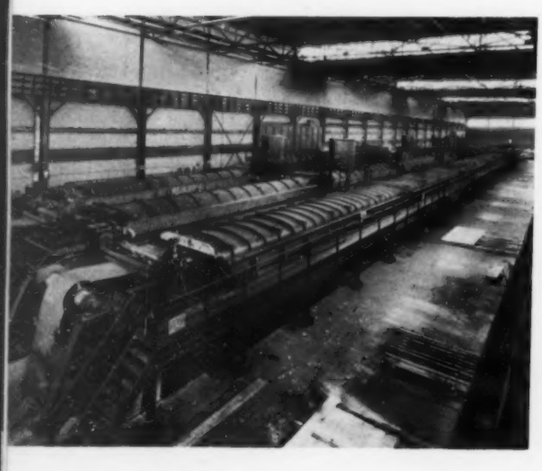
GREAT LAKES ADDS ADDITIONAL PICKLER

▲ Shown in the foreground of the lower illustration is the third and newest continuous strip pickler to be installed in the plant of the Great Lakes Steel Corporation, Detroit, Michigan. It was placed in operation last October.

Designed by engineers of the Great Lakes Steel Corporation in conjunction with engineers of The B. F. Goodrich Company, Akron, Ohio, the major acid handling equipment consists of four separate 60-ft. acid tanks and two 26-ft. water tanks. All tanks are constructed of heavily reinforced welded steel lined with Triflex rubber and sheathed inside with 8 inches of acid-proof brick jointed by a special sulphur base compound. The unit is one of the widest continuous picklers in America, having an inside finished width of 104 inches which permits the handling of strip 92 inches wide.

The pickling room is entirely free from acid fumes as the tanks are covered with sectional hoods connected to a ventilating and sewer system of a unique compact design. All auxiliary equipment is of Triflex-lined construction.

Latest of the three continuous strip picklers now in operation at Great Lakes Steel Corp., Ecorse, Michigan.



HUGE SUM INVESTED IN WIDE STRIP MILLS

▲ Approximately $350,000,000 have been invested by the steel industry in continuous sheet and wide strip mills since The American Rolling Mill Company announced ten years ago, the development and successful operation of the first continuous sheet mill, Charles R. Hook, president of the company, recently commented. The first sheet was rolled by the continuous process at Ashland, Ky., in 1923, but it was not until 1927 that the process was formally introduced to the industry.

According to present schedules there will soon be 27 continuous sheet and wide strip mills in operation in this country with a combined annual capacity of more than 14,000,000 net tons, Mr. Hook said. In addition, a continuous mill was recently placed in operation in Germany and another is under construction in Wales.

Mr. Hook, whose company has licensed all the continuous wide strip mills in the industry, said he did not fear over-capacity in normal times because the continuous mills, by improving the uniformity, size range and quality of iron and steel sheets, and at the same time substantially lowering production costs, have greatly expanded old markets and created many new markets for their products.

NEW BOOKLETS

▲ Leeds and Northrup Company, of Philadelphia, Pennsylvania, has recently issued a new booklet entitled, "Vapocarb-Hump . . . The Triple-Control Method for Heat-Treatment of Steel". This brochure, according to the manufacturer, makes a special effort to show, more clearly, than in any previously issued, the high-quality of output and far-reaching savings which complete control of tool surface, shape and structure is giving to hundreds of Vapocarb-Hump users. It is especially well illustrated, not only with views of representative installations, but with diagrams, chart records and pictures of many types of tools and dies hardened by the method. A series of action views contained in this book show in a unique way the actual steps in the method.

Leeds and Northrup have also issued another pamphlet which is called "Tempering as Jacobs Like It", giving the important details in Homo tempering of machine-tool chucks, as this operation is performed by a manufacturer noted for the quality of his product. This information is followed by a brief description of the furnace.

Copies of each of these bulletins may be obtained by writing The Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia, Pennsylvania.

▲ The Brown Instrument Company has issued a new catalog, on "Brown Automatic Boiler Regulation for Boilers under 1000 H.P., Operating at Pressures up to 300 Lbs.". In this booklet the advantages of automatic regulation are stressed and the principle of operation graphically shown. Several pages are devoted to a description of typical applications of automatic boiler regulation, showing the various methods of firing the boilers.

If you desire a copy of this publication, write to The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania. The number of this catalog is 5001.

▲ The Electric Controller and Manufacturing Company of Cleveland, Ohio, has issued a new edition of bulletin No. 910, "EC&M Separator Magnets for Removal of Tramp Iron". This new issue lists information on smaller circular magnets, rectangular magnets, and other special magnets particularly suitable for removal of tramp iron from conveyor systems handling food stuffs, copra and practically any other material such as coal, limestone, etc., used in manufacturing processes.

Contained in the booklet are the approximate recommendations for the various sizes of magnets, and dimensions of these magnets are shown in another table.

These can be obtained by addressing a request to the Electric Controller & Manufacturing Company, 2700 East 79th Street, Cleveland, Ohio.

ITEMS OF INTEREST

C. F. Blackmer resigned as president of the American Steel and Wire Company, the Cyclone Fence Company, and the Standard Fence Company. He also has relinquished directorships in these companies and smaller affiliates, all subsidiaries of the United States Steel Corporation. Mr. Blackmer has completed almost forty years of service with the American Steel and Wire Company, and one of its predecessors, the Washburn-Moen Manufacturing Company, having started with the latter in Waukegan, Illinois, in 1898. He has worked through various positions, and in 1933 was elected president. Mr. Blackmer was born April 1, 1879, at Worcester, Massachusetts. He attended public school there and at Colorado Springs, Colorado, and later graduated from Colorado College.

▲

Clifford F. Hood, executive vice president, has been elected president of the American Steel and Wire Company, the Cyclone Fence Company, and the Standard Fence Company. Mr. Hood was born in Monmouth, Illinois, February 8, 1894. He attended school at Galesburg, Illinois, and later matriculated in the University of Illinois, where he majored in electrical engineering, being graduated in 1915 with a Bachelor of Science degree. Mr. Hood's entire work since leaving college has been in the wire industry. He started first with the Packard Electric Company, Warren, Ohio, as sales engineer and assistant cable sales manager. In 1917 he joined the American Steel and Wire Company at Worcester, Massachusetts, as an operating clerk. With the exception of an interval from 1917 to 1919, when he was with the United States army, he has been with the Wire Company, moving up through the ranks as foreman, assistant superintendent, superintendent, district manager, and vice president in charge of operations. Recently he was elected a director and member of the executive committee of the United States Steel Corporation of Delaware.

▲

William Whigham, Jr., has been appointed as supervisor of personnel, methods and procedure department, of the Carnegie-Illinois Steel Corporation, with headquarters in Pittsburgh. Mr. Wigham, formerly superintendent of maintenance and industrial relations at Clairton, attended Lehigh University and Alexander Hamilton Institute. He joined the former Carnegie Steel Company as a test engineer in the efficiency department at Clairton in 1919. He held various operating positions until 1922, when he was named efficiency engineer of the Clairton Coke works. Mr. Whigham subsequently became assistant chief engineer of the by-product plant and master mechanic of the river transportation department. Following a three year period as manager of marine repairs and outfitting for Dravo Contracting Company, Mr. Whigham was named superintendent of maintenance at Clairton in 1933, and later received the additional appointment as superintendent of industrial relations at the same plant.

▲

Elmer F. Obley was appointed as superintendent of industrial relations for the Clairton plant of the Carnegie-Illinois Steel Corporation. Mr. Obley began his business career with the Westinghouse Air-brake Company in 1909, later was associated with the Pittsburgh and Lake Erie Railroad, and joined Carnegie Steel Company at Clairton in 1917. He held several positions until 1926, when he was named

C. F. BLACKMER

CLIFFORD F. HOOD

WILLIAM WHIGHAM, JR.

chief shipper of the Clairton By-Product Coke works, the position he leaves to become superintendent of industrial relations.

▲

John W. Miller has been named the superintendent of maintenance of the Carnegie-Illinois Steel Corporation's plant at Clairton, Pennsylvania. Mr. Miller, who held several positions in the mechanical, steam engineering, and erection fields in Pittsburgh from 1895 to 1905, entered the employ of Carnegie Steel Company at the old McCutcheon mills where he subsequently became chief steam engineer. He went to the Clairton works in 1918, as chief steam engineer and master mechanic, and in 1935 was appointed assistant superintendent of maintenance, his most recent position.

▲

P. W. Miller, formerly assistant superintendent of the electrical department, Clairton works, Carnegie-Illinois Steel Corporation, was made assistant superintendent of maintenance and coke. Other appointments at the Clairton plant are as follows: W. E. Fisher from general steam foreman to power engineer; J. A. Rigby from power house engineer to assistant superintendent of steel; C. Orbell from steel maintenance foreman to general foreman of steam engines; Charles Smoyer from wireman to electrical engineer, maintenance; and Adam Lee VanFosson from coke works shipper to chief shipper of coke works.

▲

J. Halsey McKown was appointed assistant vice president of United States Steel Corporation of Delaware, under C. V. McKaig, vice president in charge of sales. Offices are at 436 Seventh Avenue, Pittsburgh, Pennsylvania. Mr. McKown became identified with the steel industry September, 1905, when he entered the employ of Carnegie Steel Company. With the exception of two years in the Army during the World War, his entire career has been devoted to sales work with Carnegie Steel Company and its successors at the general offices at Pittsburgh until 1910; in the St. Louis district sales office until 1917; at Detroit district sales office, after return from the Army until September 1932, when he became assistant general manager of sales; and, upon formation of Carnegie-Illinois Steel Corporation he was made ranking assistant to the vice president and general manager of sales.

▲

Walter E. Hadley, former general superintendent of the Carnegie-Illinois Steel Corporation's Gary works, was recently named as manager of operations, Chicago district, succeeding Walther Mathesius, who on January 1, becomes vice president in charge of operations, United States Steel Corporation of Delaware. Mr. Hadley began his connection with the United States Steel corporation subsidiaries at the National Tube Company's, McKeesport, Pennsylvania, plant and was transferred in 1909 to the Ensley, Alabama, works of the Tennessee Coal, Iron and R. R. Company as assistant superintendent of blast furnaces. He served as superintendent of blast furnaces at the Bessemer, Robertsdale and Birmingham plants of the Tennessee Company. After two years as president of the Trojan Electric Steel Company of Chicago, he was appointed assistant general superintendent of Gary Works in 1918, and general superintendent in 1935. He has held the latter position until his present appointment.

▲

E. E. Moore succeeds Walter E. Hadley as general superintendent of the Gary Works of the Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Moore has been with the United States Steel Corporation subsidiaries since 1919, after he returned from oversea service in the World War. He started in the Gary sheet mill of the American Sheet and Tin Plate Company, now a part of Carnegie-Illinois. In 1923, he was transferred to the company's Pittsburgh district, returning to Gary in 1927. In 1932, he was made assistant to general superintendent of South Works

J. HASLEY McKOWN

WALTER E. HADLEY

E. E. MOORE

B. M. LIVEZEY

C. D. HENDERSON

of the then Illinois Steel Company, and in 1933 was promoted to the position of assistant to vice president. Mr. Moore was made general superintendent of South works in 1935, when the Carnegie and Illinois companies were merged to form Carnegie-Illinois Steel Corporation.

▲

B. M. Livezey will succeed E. E. Moore as general superintendent of the South works of the Carnegie-Illinois Steel Corporation at Chicago, Illinois. Mr. Livezey has been with the United States Steel subsidiaries since 1916. He served in various capacities in the Pittsburgh district and in 1926 was made superintendent of the Carnegie Steel Company's by-product plant at Clairton, Pennsylvania. He was made assistant general superintendent of the Carnegie-Illinois Steel Corporation's Clairton plant in 1936, and was transferred to the Chicago district in February 1937, as assistant to manager of operations, of the Chicago district, holding that position until his present appointment.

▲

C. D. Henderson was recently made assistant works auditor of the Gary works of the Carnegie-Illinois Steel Corporation. Mr. Henderson has been superintendent of industrial relations for the corporation's Chicago district sheet and tin mills since April of this year. He has been with the United States Steel Corporation subsidiaries since 1906, when he was employed as a clerk at the La Belle works of the former American Sheet and Tin Plate Company. From 1906 to 1927, he served in a number of positions in the Pittsburgh district, including work as order clerk, special clerk, works auditor at the La Belle works, and special assistant to the auditor in the general offices. In July 1927, he was moved to the Gary tin mill as assistant works auditor, and in 1935 was made management's representative there.

Harry M. Moses has been elected president of both the H. C. Frick Coke Company and the United States Coal and Coke Company. Mr. Moses began his business career in coal producing subsidiaries of the United States Steel Corporation, was an assistant mine foreman in 1919, and held various other supervisory positions until 1933, when he was made general superintendent of the Kentucky and West Virginia operations of United States Coal and Coke Company, which position he left at the first of the year to take over his new duties.

▲

Thomas Moses was elected vice president of the United States Steel Corporation (Delaware), in charge of raw materials. He had been president of the coal producing subsidiaries of United States Steel Corporation since 1927, and has been associated with the bituminous coal industry for more than sixty years.

▲

Charles L. Albright was recently elected vice president and secretary of the H. C. Frick Coke Company, and also was elected vice president of the United States Coal and Coke Company. Mr. Albright has served the coal producing subsidiaries in various capacities since entering business in 1905. He has been secretary of the H. C. Frick Coke Company since 1935.

▲

S. E. Graeff assistant general superintendent at the East Works plant of the American Rolling Mill Company, Middletown, Ohio, was named assistant general manager of Richard Thomas and Company, Ltd., in England, with whom Armco is now associated. Mr. Graeff will be in charge of all sheet production for the English Company, now building a new continuous mill under an Armco license for operation about June 1938. Mr. Graeff was assistant general superintendent at the Middletown plant's East Works for seven years.

CARL MOELLER

SAM T. KELLER

Carl Moeller was recently appointed Midwest district manager at the Chicago office of the Yale and Towne Manufacturing Company. Mr. Moeller, after graduating from high school, learned the trade of ornamental die sinking and worked for the Steel and Johnson Manufacturing Company, Waterbury, Connecticut. In June 1912, he went with the Yale and Towne Manufacturing Company at Stamford, Connecticut, in a similar capacity. After the World War, Mr. Moeller again took up his duties with this company in their research department. He assisted in the design and development of Yale electric trucks. In 1923 he was transferred to Pittsburgh in the capacity of district sales manager. In June 1937, he was transferred to Chicago to serve as midwest district manager of sales.

▲

Neal Leary was transferred to Chicago, becoming an associate with George Hayes, in charge of Yale and Towne Manufacturing Company's electric truck sales in the Chicago territory. Mr. Leary, who is a factory-trained representative, has been in the Pittsburgh office since January 1932.

▲

F. Gordon Ricker has been transferred from the Minneapolis office, of the Yale and Towne Manufacturing Company, to the Pittsburgh office, and is now district manager of the Pittsburgh territory. Mr. Ricker is a graduate engineer, and has had wide experience in the sale of material handling equipment.

▲

Sam T. Keller has been appointed district sales manager of the Yale and Towne Manufacturing Company, Philadelphia division, in charge of this company's activities in the Detroit, Toledo, and Grand Rapids areas. Mr. Keller will maintain headquarters at 7310 Woodward Avenue, Detroit, Michigan, and will direct activities in the sales and service of Yale electric trucks, hand lift trucks, and skid platforms. He has been prominently identified with the automotive sales field for many years. Following a number of years with the General Motors Corporation, he has in recent years been a member of the sales staff of the Chrysler Sales Corporation. In his new work, he succeeds his brother Walter T. Keller, deceased.

▲

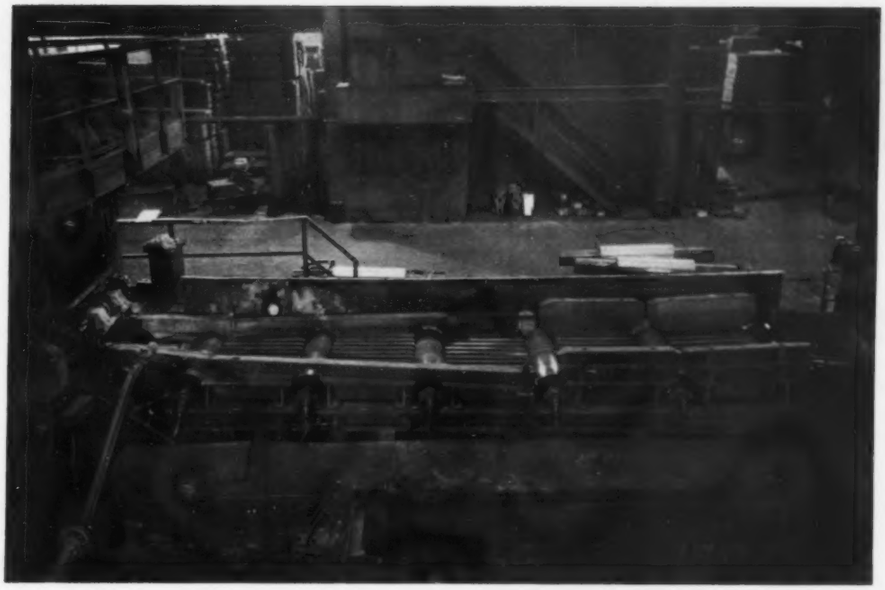
Frank A. Troxel, formerly chief engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania, has joined the Richard Thomas Steel Company, Ltd., Wales, as chief engineer of the company's new hot and cold strip mill plant at Ebbw Vale, Wales, which is now under construction. Mr. Troxel left for Wales on January 4, of this year.

▲

William M. Bailey, president of the William M. Bailey Company, Pittsburgh, Pennsylvania, has been elected a director of the Wellman Engineering Company, Cleveland, Ohio, to fill the vacancy caused by the death of Senator Atlee Pomerene.

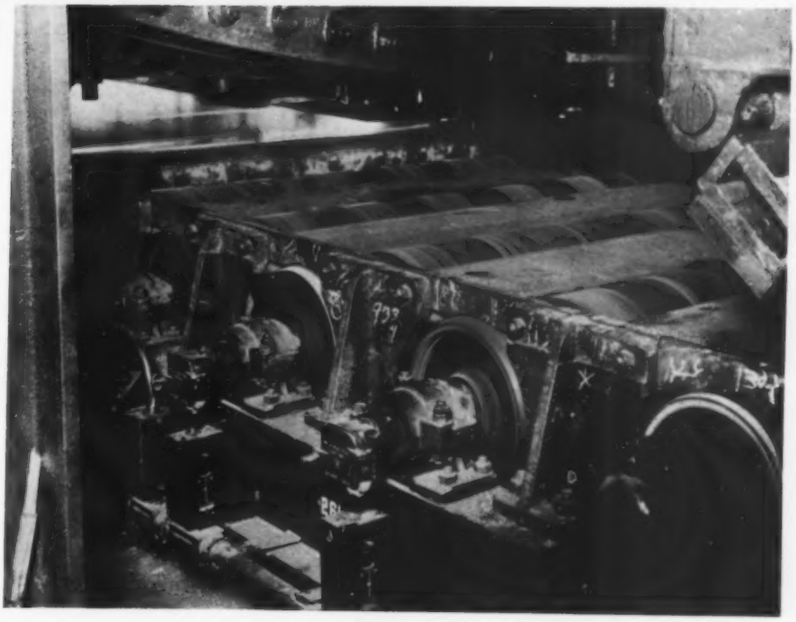
▲

Charles E. Wilson, vice president in charge of General Electric Company's appliance and merchandise department since 1930, has been elected executive vice president of the company. Mr. Wilson, has been with General Electric since 1899, beginning as an office boy. He became shipping clerk, factory accountant, and production manager, before becoming assistant superintendent of the factory in 1914. Shortly after that he was appointed sales manager. In 1918, he became assistant general superintendent of the Mazpeth and New Kensington works. In 1923, he went to Bridgeport as managing engineer in charge of the conduit and wire business. Two years later he was appointed assistant manager of General Electric's Bridgeport works. In June 1928, he became assistant



Left—"Motor-Rollers" between Mill Stands

Below—
"Motor-Roller" equipped Shear Depressing Table at Rocking Shear



With

Schloemann
"Motor-Rollers"

...installation of rollers between the housings of Mill Stands and Shear Housings is possible without introducing complicated or weak elements.

Fewer wearing parts provide the ruggedness and dependability essential in mill services with reduced operating and maintenance costs.

Each "Motor-Roller" installation is designed and built for the particular requirements of its application.

SCHLOEMANN
ENGINEERING CO. PITTSBURGH, PA.
Rolling Mill Machinery Hydraulic Presses

to the vice president in charge of the merchandise department, and in 1930 was appointed manager of the merchandise department in charge of engineering, manufacturing, and sales. In December 1930, Mr. Wilson was elected a vice president of the General Electric Company.

Mr. Wilson is chairman of the board of the General Electric Contracts Corporation; the Monowatt Electric Corporation of Providence; the Electric Vacuum Cleaner Company of Cleveland; and of Houses, Inc. He is a director in the following companies: Edison General Electric Appliance Company, Inc., of Chicago; Trumbull Electric Manufacturing Company of Plainville, Connecticut; and General Electric Supply Corporation, New York.

▲

Nathan R. Birge, assistant to the president of the General Electric Company since 1927, has been elected a vice president of the Company, it has been announced by President Gerard Swope. Mr. Birge will be located in Schenectady, where he has carried on his duties in the past.

Mr. Birge entered the employ of General Electric on August 6, 1900, following his graduation from Worcester Polytechnic Institute with the degree of Bachelor of Science in electrical engineering. In 1902, he was transferred to the former supply department of the Company, later becoming manager of the street lighting section. He was named assistant manager of the supply department in 1923, and in November of that year was transferred to the executive department. He was made assistant to the president in July, 1927.

▲

Philip D. Reed was appointed assistant to the president of the General Electric Company. Mr. Reed was born in Milwaukee, Wisconsin, on November 16, 1899. He graduated from the University of Wisconsin with the degree of electrical engineering in 1921, and from Fordham University with a doctor of laws degree in 1924. His first work was in the capacity of attorney for several companies in New York and Boston. He entered the General Electric Company's employ on November 15, 1926, as assistant to vice president C. W. Appleton of the law department. In 1928, he was transferred to the incandescent lamp department, and since July 1, 1934, has been general counsel for the law department.

Mr. Reed is a director of the Locke Insulator Corporation; General Electric Contracts Corporation; Houses, Inc.; General Electric Vapor Lamp Company; Electrical Securities Corporation; G. E. Employees Securities Corporation; and the Federation Bank and Trust Company of New York.

▲

John F. Cunningham, supervisor of production for the General Electric Company since September, 1931, has been appointed assistant to the vice president in charge of manufacturing, succeeding Myron F. Simmons, who has retired. Mr. Cunningham, a native of Valley Falls, New York, started his service with the Company on August 17, 1901, in the armature department in the Schenectady works. He was transferred to the motor department and in April, 1904, entered the test department, remaining there until November, 1906. After completing the test course he entered the turbine production department. Then followed service in the contract section, after which he became assistant to the late Langdon Gibson, production manager of the works. Later, Mr. Cunningham was transferred to the staff of H. F. T. Erben, then manager of the works, to follow important government contracts. In July, 1923, he became assistant production manager of the works, and in April, 1928, was named assistant supervisor of production for the entire company. He was appointed supervisor in September 1931, holding that position until his present promotion.

▲

Myron F. Simmons, assistant to the vice president in charge of manufacturing for the General Electric Company, has retired from active service. Mr. Simmons entered the service of the Company in 1903, and for fifteen years was in charge of the cost department of the Schenectady plant, after which he was on the staff of the Schenectady works manager until April 1928, when he received the appointment as assistant to the vice president in charge of manufacturing.

▲

Karl A. Pauly has retired from active service for the General Electric Company after thirty-nine years with that company. Mr. Pauly has held the position of engineer of the industrial department since 1922. His retirement will not deprive General Electric Company of the benefit of his long experience, as he has consented to act in a consulting capacity and will, therefore, maintain an office in the industrial department at Schenectady.

Mr. Pauly entered the General Electric Company test course in May 1899, after graduating from Massachusetts Institute of Technology with the class of 1896. In May, 1901, he joined the induction motor department, working there as a designer until July, 1905, when he was transferred to the old power and mining department. The function of this department was to recommend and engineer electric equipment for all kinds of industrial applications. His assignment during this period covered all a-c motor applications, as well as mine hoisting and steel-mill drives. In the application of electric power to these then unexploited fields, Mr. Pauly made several substantial contributions. In 1922, he was made engineer of the power and mining department and when this organization was renamed the industrial engineering department, he continued in the position of engineer.

▲

Special Notice

It is with regret that we announce in this January issue, the omission of Mr. Stephen Badlam's paper on the subject of "Developments in the Rolling of Flat Steel Products During the Year 1937".

Mr. Badlam's annual contribution was just about ready for publication when the author became quite ill, necessitating an absence from his work. We know our readers will all be glad to learn that Mr. Badlam is fast regaining his usual good health, and that his paper will appear either in the February or March issue.